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U.S. Army Environmental Center

Environmental Quality Technology Demonstration, Evaluation and Transfer Activites

Annual Report

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A summary of the program and projects managed by the U.S. Army Environmental Center, Environmental Technology Division. Report describes the project, participants, results, and requirements of the various ongoing projects. Provides points of contact for additional information.

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22a. NAME OF RESPONSIBLE INDIVIDUAL
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22c. OFFICE SYMBOL
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Environmental Quality Technology Demonstration, Evaluation and Transfer Activites

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Prepared for the U.S. Army Environmental Center

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and

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1 INTRODUCTION

This report is meant to enhance technology transfer by disseminating information on the status and plans of the U.S. Army Environmental Center's (USAEC) Environmental Quality Research and Development (R&D) Program. It is intended that the information in the report foster the synergy between the Department of the Army components, research and development counterparts in the services, other federal agencies, and private industry needed to find viable solutions for the U.S. Army's Environmental needs.

By presenting this information to users as well as other developers, USAEC hopes to avoid duplication of effort between R&D agencies with similar responsibilities and missions. In addition, timely technology transfer should also result so other developers may build upon the existing research. Users can employ this information to establish plans for incorporating the best technology available and perform their missions in an environmentally sound manner.

Readers who desire additional information should contact the designated USAEC point of contact. Readers can also request information by calling the USAEC's Army Environmental Hotline at 1-800-USA-3845. Ask for the Technology Information Exchange (TIE) Administrator. Or contact us through electronic mail sent to t2hotline@aec.apgea.army.mil. Soon you will also be able to locate us on the USAEC's homepage.

2 PROGRAM SUMMARY

The U.S. Army Environmental Center (USAEC) is committed to implementing the Army's Environmental Strategy into the 21st Century by providing the highest quality technical and program support services to Headquarters, Department of the Army, major Army commands, and installations. The Center provides these services for all elements of the Army environmental program, including: compliance, cleanup, pollution prevention, and conservation.

The USAEC's Environmental Technology Division (ETD) is dedicated to providing technical support and guidance in the transfer of environmental technology throughout the U.S. Army. The USAEC Technology Demonstration Program focuses on compliance, cleanup, pollution prevention, and conservation technologies. This program enables the Army to demonstrate the capabilities of emerging environmental technologies under actual working conditions at Army installations while gathering performance and cost information. These technologies — whether equipment, changes to procedure, or modifications to processes — may remain at the demonstration sites continuing their work, or may be taken to other installations to demonstrate their capabilities.

The efforts described in this report represent a significant portion of the Army's total Environmental Quality Technology Program. USAEC performs its projects in close coordination with other Army organizations. In this regard, the USAEC is prominent in the field of demonstration and evaluation of environmental technologies for subsequent technology transfer.

About 75 percent of USAEC's FY 94-95 program supported the Army's installation cleanup program. The remainder was primarily devoted to new technology demonstrations and technology transfer in support of mission activities and industrial operations conducted at Army ammunition plants, depots, and installations. Some of the technologies involved were generated in the private sector and adapted to Army use, while others were developed in-house. These efforts also included cost analyses and comparative evaluations to determine the best technology for particular applications.

The USAEC's policy emphasizes technology transfer to achieve rapid and effective field implementation of new technologies. USAEC personnel spend countless hours helping major command and installation staffs, as well as the U.S. Army Corps of Engineers divisions and districts, implement new technologies. These technology transfer activities primarily consist of providing technical data, performing pertinent cost analysis, preparing equipment fabrication and procurement guidance, and providing operator training, and on-site consultation.

Projects and Tasks

3 Projects and Tasks

ARAR (Applicable or Relevant and Appropriate Requirements) Support

Purpose

To provide technically sufficient and defensible documentation on the determination, description, and interpretation of ARARs (Applicable or Relevant and Appropriate Requirements) and ARAR support documentation for interim and final Installation Restoration Program (IRP) remedial actions.

Background

During the remediation of Superfund sites, Section 121 of the federal Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) requires compliance with any legally applicable or relevant and appropriate criteria, standard, or limitation established under any federal or state environmental or facility citing law. The Oak Ridge National Laboratory (ORNL) has been tasked to provide ARAR support to the U.S. Army Environmental Center (USAEC) since 1987. In determining ARARs, ORNL personnel in the Health Sciences Research Division work closely with USAEC-IRP staff, U.S. Environmental Protection Agency (EPA) and state regulators, and other Army contractors throughout the remediation process for each site. This effort consistently has either met or exceeded expectations. While serving in an advisory capacity, ORNL has presented and successfully supported the Army's position on contested ARARs in negotiations with state and EPA regulators.

Description

Separate documents are prepared for each Operable Unit to address the three types of ARARs: chemical-specific ARARs, location-specific ARARs, and action-specific ARARs. The ARARs are revised for each phase of the CERCLA process, from the Remedial Investigation through the Record of Decision. This task requires access to all current federal and state environmental regulations and a staff of environmental toxicologists and attorneys to aid in the performance of ARAR determinations.

Diagram

See Figure 1, ORNL Input to CERCLA Process at Army NPL Sites.

Applicability

This process applies to the Restoration pillar and aligns with Cleanup Goals, as outlined in the *Andrulis Report*. The Installation Restoration Program, through its site project managers, uses ORNL's documentation and determination of ARARs to ensure conformity with regulatory requirements associated with the remediation of Army sites on the National Priorities List.

Accomplishments

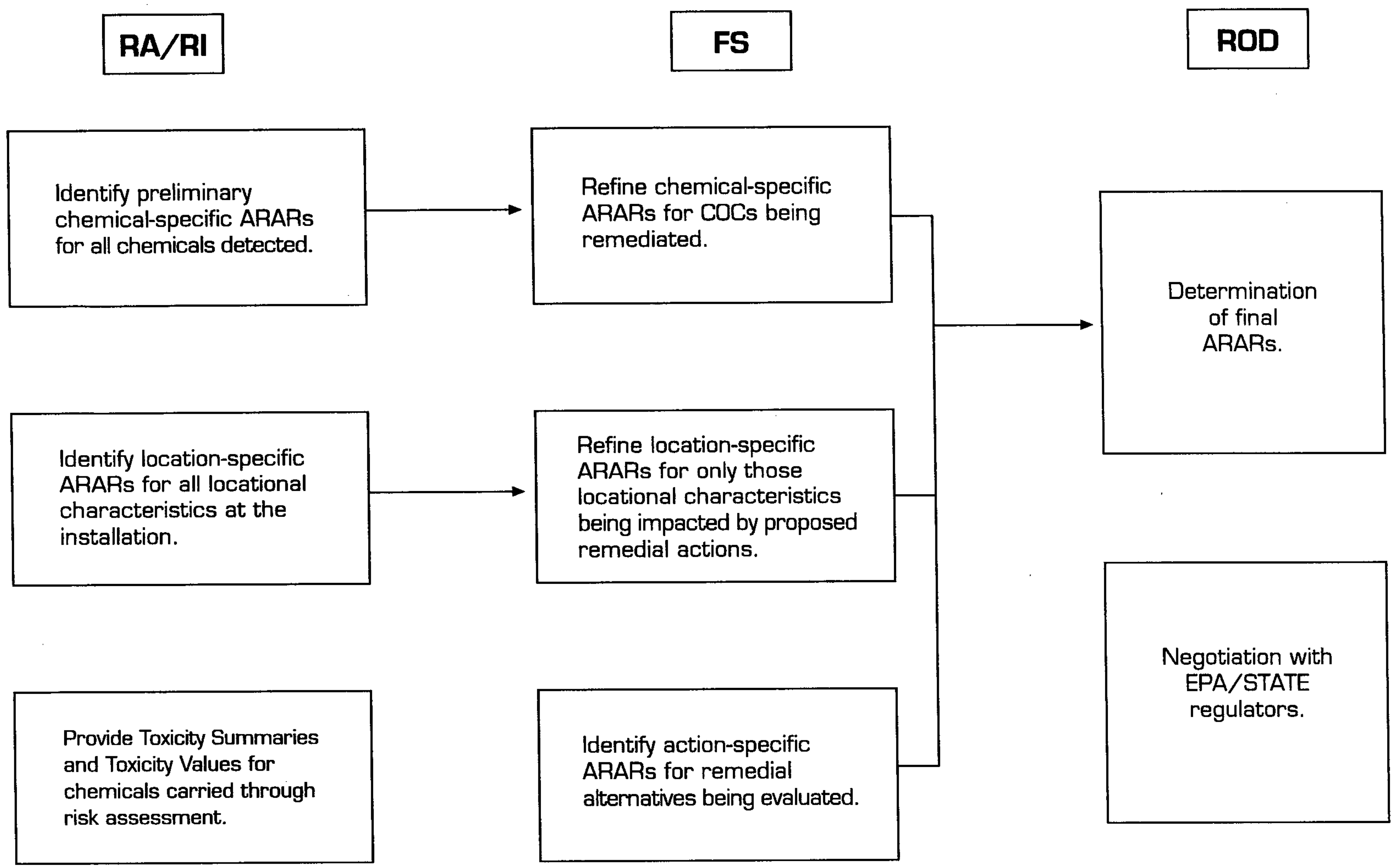
See Comment.

Performance Needs

The success of this project has been achieved in part by ORNL's ability to communicate with other Army RI/FS contractors. IRP project managers must continue to encourage open communication between ORNL staff and all parties involved in the remediation process. The project also needs continued financial support to maintain current files of state and federal laws and regulations and other regulatory reference material to ensure accurate and thorough ARAR determinations.

FIGURE 1

ORNL INPUT TO CERCLA PROCESS AT ARMY NPL SITES



Points of Contact

Robert L. Muhly
Phone: (410) 612-6839
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Fax: (410) 612-6836
E-mail: rlmuhly@aec.apgea.army.mil

Patricia S. Hovatter
1060 Commerce Park, Room 126
Oak Ridge, TN 37830
Phone: (615) 576-7568
Fax: (615) 574-9888

Available Documentation

All ARAR reports are provided in electronic or printed forms to the USAEC contracting officer's representative, Robert Muhly, and to IRP site project managers for internal review and dissemination to concerned parties. Documents are on file at ORNL and USAEC in the offices of Robert Muhly and site project managers.

Comment

The ARAR process is repetitive, as ARARs are developed and revised at various stages of the RI/FS/ROD process. USAEC initially reviews each ARAR report internally, then the EPA and state regulators review it. Each review requires revisions of the documents. In 1991, researchers decided to begin preparing documents for each type of ARAR under separate cover to accommodate the need to determine each type of ARAR during each stage of the RI/FS/ROD process.

ARAR-related work performed by Oak Ridge National Laboratory for Project RWW Environmental Support IRP from Fiscal Year 1987 (August and September) through Fiscal Year 1995 (July).

Fiscal Year 1987

Began preparation of *Desk Guide on Interpretation of Applicable or Relevant and Appropriate Requirements.*

Fiscal Year 1988

Delivered *Desk Guide on Interpretation of Applicable or Relevant and Appropriate Requirements - Interim Draft.*

Delivered *Superfund Desk Guide.*

Delivered *The Role of Health-based Criteria Development in USATHAMA's IRP.*

Delivered draft *Assessment of Applicable or Relevant and Appropriate Requirements (ARARs) for Fort A.P. Hill, Virginia.*

Delivered draft *Assessment of Applicable or Relevant and Appropriate Requirements (ARARs) for Letterkenny Army Depot, Pennsylvania.*

Fiscal Year 1989

Delivered final *Assessment of Applicable or Relevant and Appropriate Requirements (ARARs) for Fort A.P. Hill, Virginia.*

Delivered final *Assessment of Applicable or Relevant and Appropriate Requirements (ARARs) for Letterkenny Army Depot, Pennsylvania.*

Delivered draft *Assessment of Applicable or Relevant and Appropriate Requirements (ARARs) for Anniston Army Depot, Alabama.*

Delivered draft *Assessment of Applicable or Relevant and Appropriate Requirements (ARARs) for Lone Star Army Ammunition Plant, Texas.*

Delivered draft and final *Assessment of Applicable or Relevant and Appropriate Requirements (ARARs) for Sharpe Army Depot, California.*

Delivered draft *Assessment of Applicable or Relevant and Appropriate Requirements (ARARs) for Alabama Army Ammunition Plant, Alabama.*

Delivered draft *Assessment of Applicable or Relevant and Appropriate Requirements (ARARs) for Savanna Army Depot, Illinois.*

Delivered draft *Assessment of Applicable or Relevant and Appropriate Requirements (ARARs) for Milan Army Ammunition Plant, Tennessee.*

Delivered draft *Assessment of Applicable or Relevant and Appropriate Requirements (ARARs) for Riverbank Army Ammunition Plant, California.*

FISCAL YEAR 1990

Delivered draft *Assessment of Applicable or Relevant and Appropriate Requirements (ARARs) for Louisiana Army Ammunition Plant, Louisiana.*

Delivered draft and revision 1 of *Assessment of Applicable or Relevant and Appropriate Requirements (ARARs) for Fort Dix, New Jersey.*

Delivered final *Assessment of Applicable or Relevant and Appropriate Requirements (ARARs) for Milan Army Ammunition Plant, Tennessee.*

Delivered revision 1 of *Assessment of Applicable or Relevant and Appropriate Requirements (ARARs) for Riverbank Army Ammunition Plant, California.*

Delivered CASIC (Computer-Assisted Selection of Indicator Chemicals) Program.

Delivered final *Assessment of Applicable or Relevant and Appropriate Requirements (ARARs) for Alabama Army Ammunition Plant, Alabama.*

Delivered draft *Assessment of Applicable or Relevant and Appropriate Requirements (ARARs) for Lake City Army Ammunition Plant, Missouri.*

Delivered revision 1 of *Desk Guide on Interpretation of Applicable or Relevant and Appropriate Requirements - Interim Draft.*

FISCAL YEAR 1991

Delivered revisions 1 and 2 of *Assessment of Applicable or Relevant and Appropriate Requirements (ARARs) for Lake City Army Ammunition Plant, Missouri.*

Delivered revision 2 of *Desk Guide on Interpretation of Applicable or Relevant and Appropriate Requirements - Interim Draft,* incorporating changes from the final National Contingency Plan.

Delivered draft *Assessment of Applicable or Relevant and Appropriate Requirements (ARARs) for Cornhusker Army Ammunition Plant, Nebraska.*

Delivered draft *Assessment of Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Umatilla Depot Activity, Oregon.*

Delivered draft *Assessment of Applicable or Relevant and Appropriate Requirements (ARARs) for Umatilla Depot Activity, Explosives Washout Lagoon (Site 4), Oregon.*

Delivered draft *Assessment of Action-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Umatilla Depot Activity, Oregon.*

Delivered revision 2 of *Assessment of Applicable or Relevant and Appropriate Requirements (ARARs) for Riverbank Army Ammunition Plant, California.*

Delivered revision 1 of *Assessment of Applicable or Relevant and Appropriate Requirements (ARARs) for Louisiana Army Ammunition Plant, Louisiana.*

Delivered Safe Drinking Water Act chart.

Fiscal Year 1992

Delivered draft and revisions 1 and 2 of *Assessment of Location-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Tooele Army Depot, Utah.*

Delivered draft *Assessment of Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Tooele Army Depot, Utah.*

Delivered revision 1 of *Assessment of Applicable or Relevant and Appropriate Requirements (ARARs) for Lone Star Army Ammunition Plant, Texas.*

Delivered revision 1 of *Assessment of Applicable or Relevant and Appropriate Requirements (ARARs) for Cornhusker Army Ammunition Plant, Nebraska.*

Delivered draft *Assessment of Location-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Cornhusker Army Ammunition Plant, Nebraska.*

Delivered revision 2 of *Assessment of Applicable or Relevant and Appropriate Requirements (ARARs) for Louisiana Army Ammunition Plant, Louisiana.*

Delivered draft and revision 1 of *Assessment of Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Volunteer Army Ammunition Plant, Tennessee.*

Delivered draft *Assessment of Location-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Volunteer Army Ammunition Plant, Tennessee.*

Delivered draft *Assessment of Location-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Letterkenny Army Depot, Pennsylvania.*

Delivered revisions 3 and 4 of *Assessment of Applicable or Relevant and Appropriate Requirements (ARARs) for Riverbank Army Ammunition Plant, California.*

Delivered revision 1 of *Assessment of Applicable or Relevant and Appropriate Requirements (ARARs) for Anniston Army Depot, Alabama.*

Reviewed ARARs for Badger Army Ammunition Plant.

Delivered draft and revisions 1 and 2 of *Assessment of Location-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Fort Devens, Massachusetts.*

Delivered *Federal Environmental Legislative Power Curve* in hard copy and electronic form.

Delivered draft *Assessment of Location-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Sierra Army Depot, California.*

Delivered generic action-specific ARAR report, *Assessment of Applicable or Relevant and Appropriate Requirements (ARARs) for CERCLA Remedial Actions.*

Delivered revised tables for *Desk Guide on Interpretation of Applicable or Relevant and Appropriate Requirements — Interim Draft.*

Delivered draft *Assessment of Location-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Twin Cities Army Ammunition Plant, Minnesota.*

Delivered draft *Assessment of Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Twin Cities Army Ammunition Plant, Minnesota.*

Delivered Summary Table of stricted federal and state regulatory levels for chemicals in drinking water, groundwater, surface water, soil, and TCLP for the Analytical Chemistry Division at USATHAMA.

Delivered draft *Assessment of Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Shepley's Hill Landfill and Cold Spring Brook Landfill, Fort Devens, Massachusetts.*

Delivered draft *Assessment of Action-specific Applicable or Relevant and Appropriate Requirements (ARARs) for OU-1, Twin Cities Army Ammunition Plant, Minnesota.*

Reviewed ARARs in Phase 2 Remedial Investigation for the Army Materials Technology Laboratory, Watertown, Massachusetts.

Fiscal Year 1993

Delivered draft *Assessment of Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Site 14, Old Demolition Area, Lone Star Army Ammunition Plant, Texas.*

Delivered draft and revision 1 of *Assessment of Location-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Site 14, Old Demolition Area, Lone Star Army Ammunition Plant, Texas.*

Delivered draft of *Assessment of Action-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Site 14, Old Demolition Area, Lone Star Army Ammunition Plant, Texas.*

Delivered chemical-specific ARARs in table form for Western Inactive Landfill, Lone Star Army Ammunition Plant, Texas.

Delivered draft *Assessment of Action-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Remedial Actions at the South Industrial Area, Anniston Army Depot, Alabama.*

Delivered revisions 1 and 2 of *Assessment of Action-specific Applicable or Relevant and Appropriate Requirements (ARARs) for OU-1, Twin Cities Army Ammunition Plant, Minnesota.*

Delivered ARARs for the draft Record of Decision for OU-1 at Twin Cities Army Ammunition Plant, Minnesota.

Delivered revision 1 of *Assessment of Location-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Twin Cities Army Ammunition Plant, Minnesota.*

Delivered draft and revision 1 of *Assessment of Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for OU-2, Twin Cities Army Ammunition Plant, Minnesota.*

Presented ARARs for Twin Cities Army Ammunition Plant to USAEC project officers and EPA and Minnesota Pollution Control Agency regulators at two Technical Review Committee meetings.

Delivered revision 3 of *Assessment of Location-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Tooele Army Depot, Utah.*

Delivered draft *Assessment of Location-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Schofield Barracks, Hawaii.*

Delivered draft and revisions 1 and 2 of *Assessment of Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for the Property Disposal Office Area, Letterkenny Army Depot, Pennsylvania.*

Delivered draft and revisions 1 and 2 of *Assessment of Location-specific Applicable or Relevant and Appropriate Requirements (ARARs) for the Property Disposal Office Area, Letterkenny Army Depot, Pennsylvania.*

Delivered draft and revisions 1 and 2 of *Assessment of Action-specific Applicable or Relevant and Appropriate Requirements (ARARs) for the Property Disposal Office Area, Letterkenny Army Depot, Pennsylvania.*

Delivered draft *Assessment of Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Operable Unit 3, Southeastern Area, Letterkenny Army Depot, Pennsylvania.*

Delivered draft *Assessment of Location-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Operable Unit 3, Southeastern Area, Letterkenny Army Depot, Pennsylvania.*

Delivered draft *Assessment of Action-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Operable Unit 3, Southeastern Area, Letterkenny Army Depot, Pennsylvania.*

Delivered revision 1 of Safe Drinking Water Act chart.

Delivered draft and revision 1 of *Assessment of Location-specific Applicable or Relevant and Appropriate Requirements (ARARs) for the U.S. Army Natick Research, Development and Engineering Center, Massachusetts.*

Delivered draft and revision 1 of *Assessment of Action-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Shepley's Hill Landfill and Cold Spring Brook Landfill, Fort Devens, Massachusetts.*

Delivered revision 3 of *Assessment of Location-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Fort Devens, Massachusetts.*

Delivered revision 1 of *Assessment of Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Shepley's Hill Landfill and Cold Spring Brook Landfill, Fort Devens, Massachusetts.*

Delivered revised tables for *Desk Guide on Interpretation of Applicable or Relevant and Appropriate Requirements — Interim Draft.*

Delivered ARARs for the draft Record of Decision for Riverbank Army Ammunition Plant, California.

Analyzed ARARs for the draft Proposed Plan for the Record of Decision for Operable Unit 1 at Tobyhanna Army Depot, Pennsylvania.

Fiscal Year 1994

Reviewed Technical Memorandum on ARARs for Cornhusker Army Ammunition Plant, Nebraska.

Reviewed ARARs for the draft Proposed Plan for the Record of Decision for OU-1 at Cornhusker Army Ammunition Plant, Nebraska.

Delivered revision 1 of *Assessment of Applicable or Relevant and Appropriate Requirements (ARARs) for CERCLA Remedial Actions.*

Attended meeting with project officers, EPA and California regulators, and contractors to finalize ARARs for Record of Decision for Riverbank Army Ammunition Plant, California.

Reviewed ARARs for the draft Record of Decision for Operable Unit 1 at Tobyhanna Army Depot, Pennsylvania. Attended internal USAEC meeting to finalize Pennsylvania soil and groundwater ARARs for both Tobyhanna and Letterkenny Army Depots.

Reviewed ARARs for the Proposed Plan for the Record of Decision for OU-2 at the Property Disposal Office Area, Letterkenny Army Depot, Pennsylvania.

Delivered chemical-specific ARARs for trichloroethylene in groundwater at Schofield Barracks, Hawaii.

Delivered draft *Assessment of Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for the Group 1B Sites, Fort Devens, Massachusetts.*

Delivered draft *Assessment of Location-specific Applicable or Relevant and Appropriate Requirements (ARARs) for the Group 1B Sites, Fort Devens, Massachusetts.*

Delivered draft *Assessment of Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for the Fort Devens Sudbury Training Annex, Massachusetts.*

Delivered draft *Assessment of Location-specific Applicable or Relevant and Appropriate Requirements (ARARs) for the Fort Devens Sudbury Training Annex, Massachusetts.*

Delivered draft *Assessment of Location-specific Applicable or Relevant and Appropriate Requirements (ARARs) for OU-2, Twin Cities Army Ammunition Plant, Minnesota.*

Delivered revision 2 of *Assessment of Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for OU-2, Twin Cities Army Ammunition Plant, Minnesota.*

Delivered draft *Assessment of Action-specific Applicable or Relevant and Appropriate Requirements (ARARs) for OU-2, Twin Cities Army Ammunition Plant, Minnesota.*

Prepared Technical Memorandum addressing regulatory issues in the designation of a Corrective Action Management Unit at OU-2 at Twin Cities Army Ammunition Plant, Minnesota.

Delivered revised tables for *Desk Guide on Interpretation of Applicable or Relevant and Appropriate Requirements — Interim Draft.*

Reviewed ARARs in Feasibility Studies for Operable Units 2 and 4 at Joliet Army Ammunition Plant, Illinois.

Delivered revised chemical-specific ARAR tables for Volunteer Army Ammunition Plant, Tennessee.

Fiscal Year 1995 (through July)

Reviewed ARARs for OU-1 and OU-6 in FSs for Manufacturing Area at Joliet Army Ammunition Plant, Illinois, and subsequently responded to Illinois EPA comments on ARARs for OUs 1, 6, 2/4.

Provided ARARs for Pennsylvania air emissions for the PDO Area at Letterkenny Army Depot, Pennsylvania.

Provided additional regulatory support documentation for use of Corrective Action Management Unit at TCAAP, Minnesota.

Delivered chemical-specific ARAR tables for Southeast Industrial Area at Anniston Army Depot, Alabama.

Delivered chemical-specific ARAR tables for Ammo Storage Area at Anniston Army Depot, Alabama.

Delivered chemical-specific ARARs for Area 18 OU at Lake City Army Ammunition Plant, Missouri.

Delivered location-specific ARARs for Area 18 OU at Lake City Army Ammunition Plant, Missouri.

Delivered action-specific ARARs for Area 18 OU at Lake City Army Ammunition Plant, Missouri.

Delivered chemical-specific ARAR tables for North Area at Tooele Army Depot, Utah.

Delivered chemical-specific ARAR tables for South Area at Tooele Army Depot, Utah.

Delivered chemical-specific ARARs for OU-3 at Schofield Barracks, Hawaii.

Delivered location-specific ARARs for OU-3 at Schofield Barracks, Hawaii.

Delivered action-specific ARARs for OU-3 at Schofield Barracks, Hawaii.

Delivered chemical-specific ARARs for OU-4 at Schofield Barracks, Hawaii.

Delivered location-specific ARARs for OU-4 at Schofield Barracks, Hawaii.

Delivered action-specific ARARs for OU-4 at Schofield Barracks, Hawaii.

Delivered revised tables for *Desk Guide on Interpretation of Applicable or Relevant and Appropriate Requirements — Interim Draft.*

Army Environmental Technology User Requirements Survey

Purpose

To help the U.S. Army enhance its program to develop and demonstrate environmental technologies for use at military installations. The survey, based on an update of the *Andrulis Report* prepared for the Army Director of Environmental Programs in 1993, will help the Army better identify opportunities to demonstrate and use innovative, cost-effective technologies.

Background

The Department of Defense (DoD) Tri-Service Environmental Quality Strategic Plan (EQSP) is a collaboration among the military services to program future research and development (R&D) and implementation efforts that support the use of new technologies and processes. The R&D program efforts identified within the Tri-Service EQSP are mandated to directly support specific requirements identified within the DoD user community. These "user requirements" are identified separately within each service's environmental cleanup, pollution prevention, compliance, and conservation pillars. The EQSP is updated annually and published in what is known as *The Green Book.*

The Army identified and ranked an initial set of user community environment technology requirements in the *Andrulis Report,* a 1993 study that identified and prioritized the Army's highest cleanup, compliance, pollution prevention and conservation problems requiring technology research and development. The first of its kind, the study resulted from an intensive effort involving representatives from Army installations and agencies.

In 1994, DoD prepared the "DoD Environmental Technology Requirements Strategy," which has the goal of integrating the user requirements of all the services. To accomplish this, DoD requested the services reformat their users' environmental technology requirements using a proposed uniform format that calls for detailed quantified data.

Description

This U.S. Army Environmental Center (USAEC) study will expand and update the *Andrulis Report.* It also will identify technology needs that can be immediately addressed with off-the-shelf technologies currently available within private industry.

The environmental technology requirements survey will be conducted in several phases. The first phase will consist of planning and developing a user survey format with an extensive review and retrieval of survey information from existing data sources. Data collection will continue in the second phase through visits with the user community at Army installations. This phase also will consist of processing the final results for further cost-benefit analysis and ranking. The third phase will consist of planning, developing, and implementing methods to automate the process of maintaining environmental user technology requirements.

Limitations

The effort to conduct an Armywide survey of its environmental technology requirements is extensive. Phase one of the survey is limited to the review of existing data sources because a "data call" into the user community is expensive and time-consuming. However, many of these data sources were created for specific purposes and may not provide all the required information. Dedicated resources and time are required to complete a comprehensive study. Available resources threaten to limit the collection of information needed to quantify the Army's environmental technology requirements.

Diagram

See Figure 2, DoD Environmental Technology Planning Process Overview

Applicability

Many technical solutions to the Army's requirements may exist but are not used because the required demonstration or validation has not been performed. The time and cost required to implement some readily-available commercial technologies are potentially far less than those associated with the complete research and development process. In some cases, use of an available technology may require changes to military specifications or manuals. The emphasis on cost-benefit analyses in the USAEC study is intended to help the military get the best return from its research and development efforts.

Accomplishments

The USAEC study should enhance communication between the "users" of environmental technology and the Army's research and development community. Representatives of the organizations with technology requirements will be able to use the USAEC study to share lessons learned.

The first phase of the survey is under way and completion is expected by the third quarter of FY 1996. The second and third phases should start before the end of FY 1996 and finish within a year.

Point of Contact

Edward Engbert

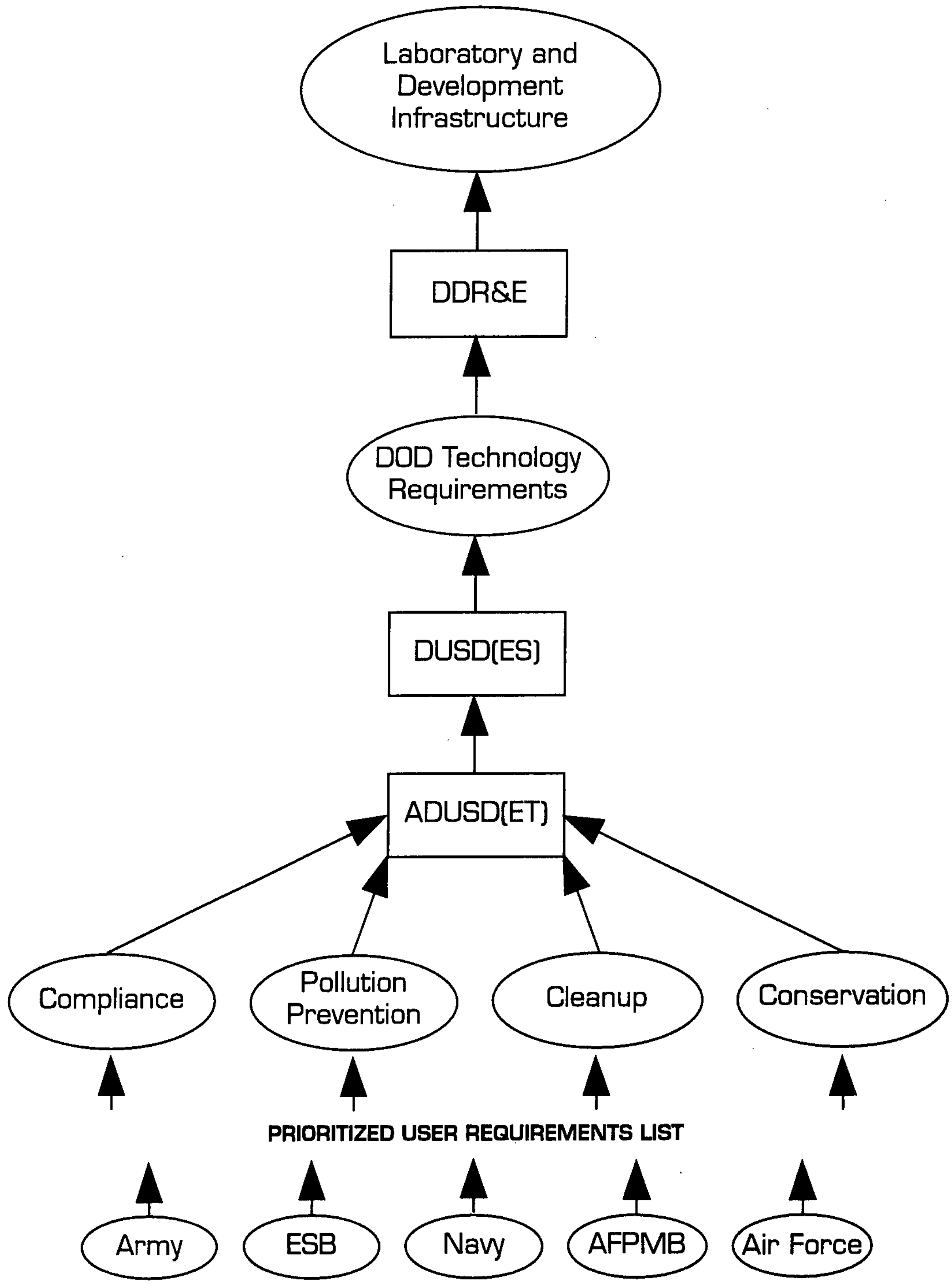
Phone: (410) 612-6867
DSN: 584-6867
Fax: (410) 612-6836
E-mail: egenber@aec.apgea.army.mil

Available Documentation

Final report and database are expected by the end of 1st Quarter FY 1996.

Figure 2

DoD Environmental Technology Planning Process Overview



Army National Environmental Technology Test Sites (NETTS) Program

Purpose

To provide National Test Locations (NTLs) for comparative demonstration, evaluation, and transfer of innovative explosives remediation, site characterization, and monitoring technologies.

Background

Past processes for gaining acceptance of cost effective innovative , environmental technologies to remediate federal installations was complex, labor intensive, and costly. The problem hampers innovation, impedes technology transfer, and hinders accelerated cleanup. Analysis of the technology development and transfer process has shown that these problems stem from the following reasons: the lack of certification of new technologies as presumptive remedies; the lack of formally established technology demonstration programs that ensure protocols and quality assurance/quality control procedures meet requirements of regulators and users; and a lack of information disseminated in formats suitable for all interested parties. The NETTS program is addressing these problems.

Funded by the Strategic Environmental Research and Development Program (SERDP), the NETTS program teams the Army, Navy, Air Force, and U.S. Environmental Protection Agency (EPA) to address these concerns. The NETTS program provides test locations for comparative demonstration and evaluation of innovative environmental technologies in order to expedite their transfer and implementation from research to full scale use.

NETTS accomplishes its objectives through the following initiatives:

- Involvement of users, regulators, public, and private sectors throughout the technology demonstration process;
- Providing well characterized test locations, infrastructure, field and analytical support required to demonstrate and evaluate innovative technologies;
- Standardization of data collection and analysis protocol among the partnering military services;
- Quantification of information and data requirements from technology demonstrations for regulators, installations, and public use in order to facilitate understanding of the technology's performance capabilities;
- Transfer of successful technologies through targeted distribution of technical evaluations, guidance specifications, and cost and performance data.

Dedicated and focused National Test Locations allow better use of resources and prevent duplication of effort. In addition, the process involved in fielding innovative technologies for demonstration can be easily facilitated since permitting, characterization, infrastructure, and on-site field support are already in place.

Immediate benefits of an integrated demonstration and evaluation program include:

- Identification of achievable and cost-effective goals for cleanup;
- Establishment of a test and evaluation platform for advancement of remediation technologies;
- Accelerated acceptance of innovative technologies as presumptive remedies for reduction in the time and cleanup cost;
- Well-documented engineering packages (where appropriate) for the broader application of effective technologies;
- Return on investment and cost savings for technology demonstrators; and
- Advanced understanding of the fate and transport of contaminants.

In addition to these activities, the Army (with the assistance of the other NTL managers), developed a comprehensive technology demonstration guidance document. This document includes guidance and templates for writing test plans, QA/QC plans, HSPs, and QAPPs. Also included are technology execution criteria for successful regulatory and user interfaces.

Another effort conducted by the U.S. Air Force project at McClellan Air Force Base, CA, involved development and incorporation of a database that will serve as a repository for demonstration cost and performance data.

Description

Past manufacturing and disposal practices have left explosives in soil, sediments, and groundwater at many DoD industrial facilities. Under the auspices of SERDP, NETTS test sites focus on solving military-unique and priority contaminant situations and concerns. The Army's objective in this program is to expedite demonstration, evaluation, and transfer of effective environmental technologies aimed at characterizing, remediating, or attenuating sites contaminated with explosives and related nitroaromatic compounds.

The Army's NTL is located at Volunteer AAP, near Chattanooga, TN. At VAAP, soil and groundwater contaminants consist principally of explosives and explosives manufacturing related contaminants (TNT, DNT, and nitroaromatics). Most soil contaminants are located near old buildings, or their remains used to batch-manufacture TNT. Contamination has been detected in the vadose zone but has not been traced to entry points.

The VAAP NTL offers an on-site laboratory capable of providing immediate analytical feedback on technology demonstration process parameters and associated QA/QC. A technology selection criteria includes the applicability to Army needs, potential to meet established cleanup levels, and potential cost savings over currently used technologies. Technologies with potential for demonstration can come from government laboratories, from private firms under Broad Agency Announcement solicitations, or through Cooperative Research and Development Agreements.

Table

See Table, NETTS Project Events and Milestones.

Table 1

NETTS Project Events and Milestones

Event No.	Action	Responsible Party	No. Days	Cum. Days
1	Proposal Received from Prospective Demonstrator	ICI/USAEC	0	0
2	Proposal Review and Demonstrator Qualifications Evaluation	USAEC	15	15
3	Tentative Acceptance of Project *(15 days from proposal submittal)*	USAEC	0	15
4	Technology Demonstration Workplan (TDW) Submittal *(60 days from USAEC's tentative acceptance)*	Demonstrator	60	75
5	Site Selection Action *(30 days from TDW submittal)*	USAEC/Steering Committee/Demonstrator	30	105
6	Comprehensive Review of TDW & Project Proposal *(45 days from TDW submittal)*	USAEC/Technical Review Committee	45	120
7	Formal Acceptance as Demonstration Project and Approval of TDW *(45 days from TDW submittal)*	USAEC	0	120
8	Completion of Demonstration Agreement *(45 days from TDW submittal)*	USAEC/ICI/ VAAP/Demonstrator	45	120
9	NEPA Documentation *(45 days from TDW submittal)*	Demonstrator/ICI/ VAAP	45	120
10	Permit Application Submittal *(15 days from completion of demo agreement)*	ICI/Demonstrator/ VAAP	15	135
11	Modifications to QAPP *(if necessary)* *(60 days from TDW submittal)*	ICI	60	135
12	Demonstration-Specific Health & Safety Plan (HSP) *(30 days from USAEC's formal acceptance of project)*	Demonstrator/ICI	30	150
13	All Documentation Completed/Approved	USAEC	0	150
14	Permitting Action *(if necessary)* Completed	Various Regulatory Agencies	0	150
15	Conduct Test Activity *(30 - 180 days, on average)*	Demonstrator/ICI/USAEC	varies	0
16	Site Restoration, as required *(15 days from end of project)*	ICI/Demonstrator	15	15
17	Waste Disposal *(90 days from initial generation or 30 days from end of project)*	ICI/Demonstrator	90	30
18	Preparation of Draft Report *(30 days from end of project)*	Demonstrator	30	30
19	Technical Review of Draft Report	Technical Review Committee	30	60
20	Final Report to USAEC	Demonstrator	15	75

LIMITATIONS

May be project-specific.

APPLICABILITY

The Army SERDP NETTS National Test Locations support several DoD cleanup pillar programs and restoration requirement statements as identified in the Tri-Service Environmental R&D Strategic Plan and the U.S. Army Environmental R&D Requirements (*Andrulis Report*), respectively. Tri-Service Environmental R&D Strategic Plan program goals that NETTS NTLs support are:

- 1.F.1, Explosives/Organics Contaminated Groundwater-Biological
- 1.F.2, Explosives/Organics Contaminated Groundwater-Physical/ Chemical
- 1.J.1, Explosives/Organics Contaminated Groundwater-Biological
- 1.J, Explosives/Organics Contaminated Groundwater-Physical Chemical

Army NTLs also have the capacity to support research, demonstration, and evaluation for the following Army-specific cleanup requirements:

- 1.2.a, Explosives in Groundwater
- 1.2.b, Organics in Groundwater
- 1.2.f, Alternatives to Pump and Treat
- 1.3.a, Remediation of Explosives in Soil
- 1.5.g, Hazard/Risk Assessment of Military-Unique Compounds
- 1.3.b, On-site Treatment of Organics Contaminated Soils
- 1.5.c, Hazardous and Explosives Fate/Transport Predictions
- 1.3.k, Develop Unified Organics/Inorganics Treatment Technology
- 1.3.m, Soil Bioremediation
- 1.3.h, Determine Natural Attenuation Rates of Army-Unique Compounds
- 1.3.i, Soil Treatment Under Structures

ACCOMPLISHMENTS

During FY93, the USAEC screened several candidate facilities and installations from the Installation Restoration Program to select suitable explosives NTLs. By the end of FY94, the USAEC negotiated and coordinated the establishment of VAAP as the Army's first NETTS NTL. In FY95 the Army conducted in-depth site characterization, developed test-site infrastructure and performed administrative, logistical, and oversight functions necessary to establish VAAP as an NTL. These activities included: conducting site and environmental assessments; permit and regulatory review; developing site specific management and health and safety plans; developing test site infrastructure; setting up and validating the analytical laboratory; and coordinating with potential government and private industry technology demonstrators.

The first project to utilize the VAAP test site for the purpose of a field test was the Site Characterization and Analysis Penetrometer Systems (SCAPS). USAEC also managed the development of the Guidelines for Quality Technology Demonstrations document, which will assist the DoD and EPA NETTS partners in their efforts to implement common demonstration standards and uniform analytical protocols.

PERFORMANCE NEEDS

Under the auspices of the Army SERDP NETTS program, the USAEC has developed infrastructure and performed detailed site characterization at Army NTLs to facilitate technology demonstration and evaluation. As such, the Army does not directly fund private industry technology demonstrations at Army NETTS NTLs. Technology demonstrators on other than SERDP sponsored projects are responsible for securing funding for project-specific costs such as field support, analytical support, waste disposal, and other fixed and variable project specific cost.

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AVAILABLE DOCUMENTATION

Demonstration of Defense National Environmental Technology Demonstration Program, Guidelines for Quality Technology Demonstrations, December, 1995, SERDP.

Volunteer Army Ammunition Plant DoD National Environmental Technology Test Sites Management Plan, March 1996, USAEC.

Site Characterization of Volunteer Army Ammunition Plant Technology Demonstration Area, December 1995, USAEC.

Environmental Assessment for Establishment of a National Test Location at Volunteer Army Ammunition Plant, November 1995. USAEC.

Heath and Safety Plan - National Environmental Technology Test Sites, Volunteer Army Ammunition Plant, June 1995, USAEC.

Quality Assurance Project Plant - National Environmental Technology Demonstration Program Test Site, Volunteer Army Ammunition Plant, May 1995, USAEC.

Louisiana Army Ammunition Plant DoD/National Environmental Technology Test Sites Management Plan, March 1996, USAEC

Environmental Assessment for Establishment of a National Test Location at Louisiana Army Ammunition Plant, November 1995, USAEC.

Heath and Safety Plan - National Environmental Technology Test Sites, Louisiana Army Ammunition Plant, November 1995, USAEC.

Analysis and Reactions of Degradation Products of Sulfur Mustard in the Environment

Purpose

To develop and evaluate a potential fate model of thiodiglycol in soil and to determine the factors of degradation kinetics involved in the process.

Background

The U.S. Army Environmental Center (USAEC) has been tasked to identify and clean up contaminants found on or near Army installations. Some of these contaminants result from past or current manufacturing, testing, storing and disposing of munitions containing chemical warfare agents. Soil and groundwater near these operation sites may contain chemical warfare agents and their degradation products.

Description

This project will use different methodologies to determine the best. Work, on contract, continues.

Limitations

The technology must apply to a full range of degradation products, but this list of products must be determined.

Applicability

This project applies to the Restoration pillar and addresses the following Army Requirements Statements:

- A.1.1 Develop Improved Field Analytical Techniques (1.1.a)
- A.1.9 Standard Analytical Methods for Army-Unique Compounds (1.1.i)
- A.1.13 Organics in Groundwater (1.2.b)
- A.1.24 Determine Natural Attenuation Rates of Army-Unique Compounds (1.3.h)
- A.1.38 Chemical Warfare Material Fate/Transport Prediction (1.5.a)

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Antifreeze Recycling

Purpose

To gain experience in installing, training and operating DoD-approved antifreeze recycling units at user sites

Background

Recycling used antifreeze, a hazardous waste because of its toxicity, is an approved pollution prevention technology. The Tank and Automotive Command Research, Development and Engineering Center detachment at Fort Belvoir, Va., has approved two antifreeze recycling units for Army use. This effort is the result of the USAEC Environmental Compliance Division's need for implementation of this technology. The USAEC Environmental Technology Division works in close coordination with Fort Belvoir during the execution of this effort.

Description

This project will install the approved units at four operating sites, of the U.S. Army Forces Command, U.S. Army Training and Doctrine Command, U.S. Army Reserve Command, and the National Guard Bureau. The purpose is to gain experience installing, starting up and operating these units and to publish the lessons learned in this project for Armywide use. Researchers will develop training and maintenance guidance for the Army-specific use of this equipment.

Limitations

No known limitations exist for the proper use of this equipment.

Applicability

All Army and DoD vehicles.

Accomplishments

Funds have been transferred to Fort Belvoir to purchase the four units. Four demonstration sites have also been selected and installed.

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Available Documentation

Antifreeze Recycling Users Guide (call POC above for copy). Belvoir Research, Development and Engineering Center, Letter Report 94-2.

Application of GIS and Remote Sensing for Resource Management in the Northern Chihuahuan Desert

Purpose

This study was an assessment of the utility of remotely sensed images and GIS for analyzing land use and land cover in a semi-arid environment. The application of these tools, in conjunction with ancillary data, could allow resource managers to accurately assess change over a vast area.

Background

Ground-based studies have shown soil compaction and erosion, loss of vegetation, and disruption of wildlife habitat to be common impacts of off-road and tracked-vehicles on the landscape. While field surveys of the impacts could be used, such an effort at Fort Bliss would be very labor intensive due to its size (over 137,000 ha).

Remote sensing-based studies of arid lands have proven useful in gaining an understanding of this fragile environment. Imagery from remote sensors, such as Landsat Thematic Mapper (TM) and Systeme Pour l'Observation de la Terre (SPOT), offer spatial and spectral resolutions which can be used to study this type of terrain. Techniques of image processing can be used to detect some of the physical changes that may be attributed to tracked-vehicle training over time. In addition, these satellite-based sensors offer repetitive coverage of large areas for temporal monitoring of the landscape. Investigations at Fort Bliss will help determine if remote sensing can be useful for linking data on ground-based military activities to landscape change.

Cultural issues are a significant factor to consider when making responsible land management decisions. The importance of these issues requires examination of the impacts that current military practices may have on cultural resources. For example, an accurate assessment of current levels of damage to know archaeological sites would facilitate the rezoning of training areas. Use of remote sensing to detect particular archaeological features not readily apparent on the ground may provide a new technique to further field studies in an attempt to find undiscovered archaeological sites.

Description

In order to address a variety of issues regarding the application of GIS and remote sensing in semi-arid environments, the project was divided into four groups:

a) Training Impact Assessment Group (TIAG)

b) Ecological Assessment Group (EAG)

c) Cultural Resource Management Group (CRMG)

d) Jornada Long Term Ecological Research Group (LTER)

The four groups proposed to analyze a number of issues pertinent to resource managers in the northern region of the Chihuahuan Desert. The groups assessed the utility of remote sensed images and GIS for analyzing land use and land cover in a semi-arid environment.

TIAG Objectives

Assess utility, characterize observed changes and correlate landscape change with data on training loads.

EAG Objectives

Assess applicability, assess use of GIS in known landscape features with remotely sensed land cover types, apply habitat classification scheme and use habitat cover to develop a GIS for identification of ecological and cultural resources.

CRMG Objectives

Detect historic trails, correlate geomorphological field studies with remotely sensed images, develop signatures for archaeological sites and present suggestions for implementation of predictive model and Cultural Resource Management.

LTER Objectives

Demonstrate/evaluate Landsat TM, Examine how ecological classification varies in relation to scale and examine the utility of Landsat TM to monitor land cover changes.

Limitations

TIAG

- Spatial registration of multi-date imagery will be critical to the change analysis.
- Land cover and other spectral classifications and analyses will depend on available spectral signatures of the land cover and on spectral calibrations between dates.
- It may not be able to distinguish between natural changes and those changes due to vehicle maneuvers.
- It is unknown if discrimination between vegetative species of this area can be derived from the remotely sensed imagery. The high reflectivity of the soil, sparse vegetation cover, and spatial limitation of the satellite sensors will make land cover classification difficult.

EAG

- There is a dependency of the accuracy of the LCTA data.
- There may be a problem in identifying an image classification methodology that can accurately identify the land cover types needed for the habitat classification scheme.
- The group is highly dependent on existing ancillary GIS coverages that have accuracy and scale sufficient to be incorporated with land cover (image) layer to produce the habitat unit map.

CRMG

- The roads may be too narrow to be discerned in most remotely sensed images.
- The geomorphological work attempted in this study depended heavily upon the quality of the work done previously on the base and whether it is applicable to remotely sensed analysis.

- The radar data may not penetrate the sand to a depth that will be useful for the stated purposes.
- There is a chance that the spectral signature of vegetation growing over archaeological sites falls within the expected variability of the vegetation not growing over archaeological sites.
- The issue of scale also weighs in heavily on these topics.

LTER

- Air photos may not be available.
- Inability to distinguish land cover types due to dominant background reflectance of soils.
- Inability to obtain distinct training data for land cover because of changing soil reflection with moisture or sun angle.

Applicability

This project fulfilled the user requirements; Land Capability, Mitigating Army Uniques Impacts and Measuring Accumulative Effects, as outlined in the *Andrulis Report*.

Accomplishments

Our investigations at Fort Bliss helped determine if remote sensing could be useful for linking data on ground-based military activities to landscape change.

The use of remote sensing to detect particular archaeological features not readily apparent on the ground provided new techniques to further help the Fort Bliss staff discover and catalog sites on base lands. The use of GIS to construct predictive models will help guide future field studies in an attempt to find undiscovered archaeological sites.

Performance Needs

Pilot project needs to be implemented to reveal subpixel demixing showing actual ground cover.

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Applications of Remote Sensing to Army Installation Natural and Cultural Resource Management (TEC Workshop)

Purpose

The workshop was to meet three objectives:

1) Outline in matrix format the various sensors that apply to resource management;
2) Discuss in a report the pros and cons of using various sensor data; and
3) Present a workshop at TEC showcasing the remote-sensing tools to Army installation managers.

Background

Congress has mandated consistently that federal lands be well-managed. This mandate can interfere with the military's mission to respond to national defense and emergency situations. The military must maintain realistic training environments and conserve its natural resource base, even when using land for high-impact training. Stricter enforcement of environmental laws and regulations also has raised the need for conservation and compliance. As a result, inventory and monitoring of natural and cultural resources have become priorities.

Army installation natural and cultural resource managers are responsible for maintaining the natural resources to support military activity.

Many experts consider remote sensing as a workable technology for monitoring and assessing natural and cultural resources. This project formally has evaluated the many sensors available today and has assessed their application to resource management.

Description

The workshop searched the literature for state-of-the-science capabilities and gathered information during visits and conversations with the Army and National Guard. Select U.S. Army Corps of Engineers (USACE) laboratory personnel and installation managers showcased the remote-sensing technologies and applications.

An opening panel introduced the projects demonstrated during a derived product poster session. Discussions during the poster session thoroughly examined each product's advantages and limitations and described its creation. The discussions concentrated on currently available products and products which are still being tested and demonstrated, but soon to be available. They focused on products applicable to natural and cultural resource managers and not on collection techniques. A final report indexed references of practical applications from the abstracts, papers on the presentations and working group sessions, laboratory synopses on respective terrain features, laboratory abstracts for future R&D, demonstrations, technology transfer, and user feedback.

LIMITATIONS

Remotely sensed multispectral data could help installations better manage their natural and cultural resources. But many installations don't use it, either because of cost limitations or they don't know about the technology.

ACCOMPLISHMENTS

- Coordination of the USACE laboratories with numerous government agencies and installations, including USAEC, the Directorate Research commands, and Army and National Guard installations.
- USAEC is developing significant efforts to transferring application-specific procedures of remote-sensing technology.
- The workshop opened new channels of communication between the USACE laboratories and natural resource managers at installations. Both the USACE and installation participants better understand the needs and capabilities of each other. This improved understanding of the installation requirements will help to tailor future workshops and efforts to address these needs.

PERFORMANCE NEEDS

The workshop met its goals, but the installations still need baseline data. They also need better access to remote-sensing technology within their budgets and applications.

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AVAILABLE DOCUMENTATION

Final Report: Application for Remote Sensing for Natural and Cultural Resource Management, 30 May 1995.

BIODEGRADATION OF LIQUID GUN PROPELLANT FORMULATION 1846 (LGP)

PURPOSE

Large-scale use of LGP inevitably will generate LGP-contaminated materials and residuals that require treatment or disposal.

BACKGROUND

A clear, colorless, and odorless liquid, LGP is a molten salt composed of hydroxylammonium nitrate (HAN, 60.79 percent, 9.09 molar), triethanolammonium nitrate (TEAN, 19.19 percent, 1.3 molar), and water (20.02 percent, 15.93 molar). When mixed completely with water, the two salts dissociate to yield nitrate and hydroxylammonium and triethanolammonium ions. Properties of LGP have led to its selection as the propellant for a new 155mm howitzer. The U.S. Army Armament Research, Development and Engineering Center is conducting a life-cycle assessment of this propellant. The U.S. Army Environmental Center (USAEC) conducted this research and development in support of this program.

DESCRIPTION

Activities included screening and selecting microbes capable of tolerating LGP; developing an analytical method capable of quantifying low levels of LGP in environmental samples; evaluating degradation of LGP in soil and water matrices; and evaluating the effectiveness of sequencing batch reactors (SBR) for treatment of LGP in an aqueous matrix.

LIMITATIONS

The LGP inhibits or is toxic to soil microbes at levels above 800 ppm. Also, HAN degrades quickly in environmental samples by physical and chemical reactions, and TEAN resists biodegradation.

APPLICABILITY

This research applies to LGP and its components HAN and TEAN.

ACCOMPLISHMENTS

In addition to the assessment of LGP's biodegradability, the advancement of a high-performance chromatography analytical method significantly contributed to this research and development effort.

PERFORMANCE NEEDS

This project needs further investigation of the feasibility of TEAN's biodegradation using SBRs and a longer biological solids retention time. It also needs full validation of the HPLC analytical method, including interlaboratory studies with round-robin analysis and identification of matrix interference, and development of a standardized method to extract LGP from soils to quantify contamination.

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Available Documentation

Biodegradation of Liquid Gun Propellant Formulation 1846. Final Report. USAEC Report No. SFIM-AEC-ETD-CR-95026, February 1995.

Composting of Propellants

Purpose

To demonstrate composting as an environmentally acceptable method to dispose of nitrocellulose (NC) fines.

Background

Manufacturing NC, a highly substituted cellulose fiber used as a propellant, produces out-of-specification NC fines. These fines historically have been discarded by discharge into lagoons. However, this practice no longer is acceptable. Several methods of rendering NC fines inert have been investigated in the past with only limited success. However, two previous U.S. Army Environmental Center (USAEC) studies, *Task Order 12 Field Demonstration — Composting of Propellants Contaminated Sediments at the Badger Army Ammunition Plant (BAAP)* and *Process and Economic Feasibility of Using Composting Technology to Treat Waste Nitrocellulose Fines,* indicate composting may be a feasible option for the disposal of NC fines.

Description

In composting, a controlled biological process, microorganisms convert biodegradable hazardous material to innocuous, stabilized by-products, typically at elevated temperatures between 50 C and 55 C. The increased temperatures result from heat produced by indigenous microorganisms as they degrade the organic material in the waste. The NC fines mix with bulking agents and organic amendments, such as wood chips and animal and vegetable wastes, to enhance the porosity of the mixture to decompose. Maintaining moisture content, pH, oxygenation, temperature, and the carbon-to-nitrogen ratio achieves maximum degradation efficiency.

The hazards analysis as well as the evaluation of the regulatory, logistical, and economic feasibility has been completed. These projects precede a pilot demonstration of composting NC fines.

Diagram

See Figure 3, Composting of Propellants

Limitations

- Composting requires substantial space.
- Composting increases the volume of material because of the addition of amendment material.
- Prior analytical methods used to determine the NC fines content in the compost produced disputable results.
- A definitive analysis method is not currently available.

Applicability

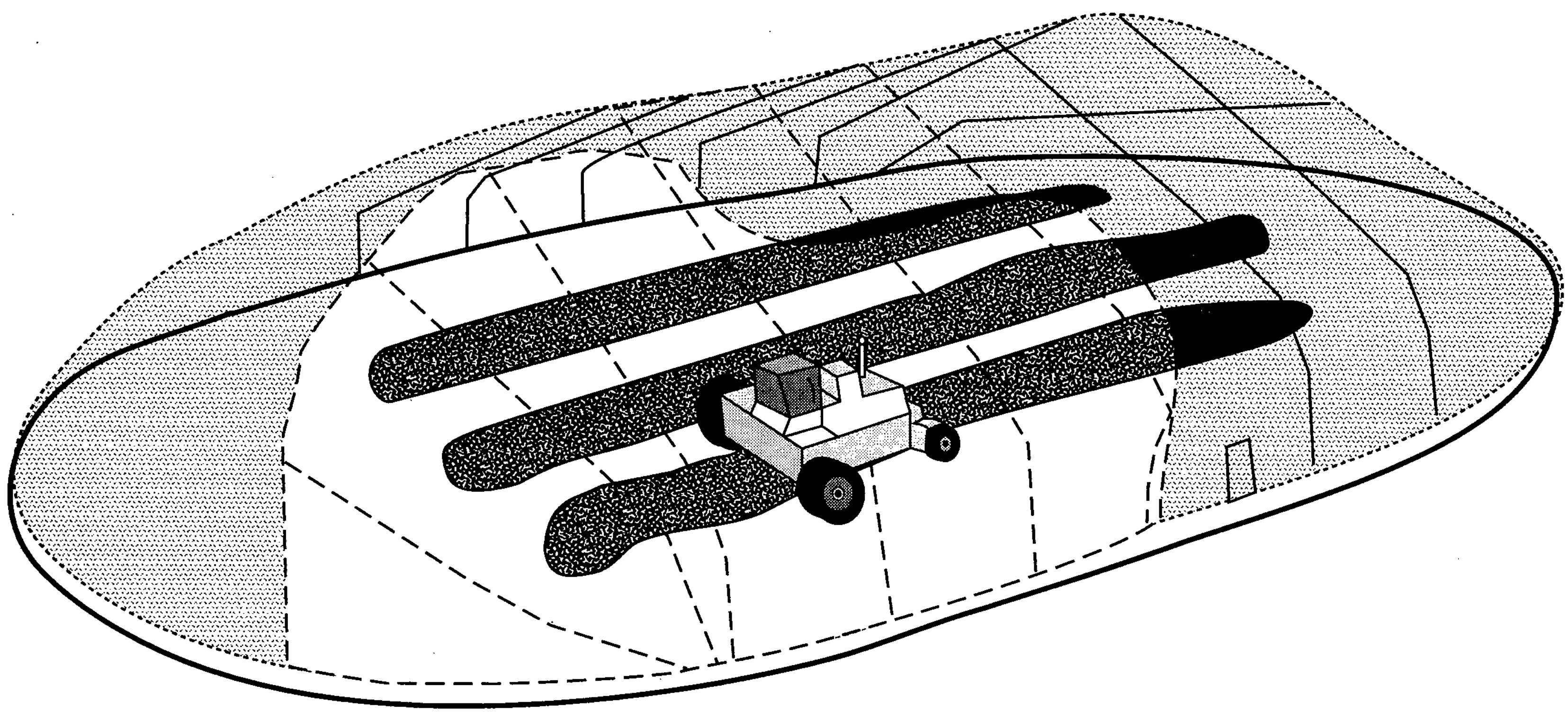
This technology applies to the Restoration and Compliance pillars. The Army Requirements Statements addressed include:

- 1.3.a Remediation of Explosives in Soil
- 1.3.m Soil Bioremediation
- 2.2.a Develop Treatment Technologies for Wastewaters from Munitions Production
- 2.3.a Alternatives to OB/OD

Figure 3

Composting of Propellants

Excavate NC Fines → Form Windrows w/NC Fines and Amendments → Periodic Turning of Windrow → Windrow Monitoring → Compost Analysis → Windrow Disassembly and Disposition



Composting offers an alternative treatment technology for the following:

a) Remediation of soils contaminated with NC fines

b) Disposal of NC fines stored at Army facilities

c) Disposal of NC fines generated from the production of nitrocellulose

Accomplishments

An evaluation of various options for recovering and treating and disposing of nitrocellulose in the manufacturing wash streams at Radford Army Ammunition Plant (RAAP), Va., indicated that biological treatment may provide a feasible alternative for the disposal of waste NC fines.

A field demonstration at Badger Army Ammunition Plant, Wis., determined that composting can successfully biologically degrade the NC in soils contaminated with NC-based propellants.

An economic and process feasibility study indicated that composting of NC fines is technically and economically feasible. Significant progress also has occurred in the development of composting to remediate soils containing explosives.

Performance Needs

The hazards analysis to determine the reactivity of a compost pile, and the regulatory, logistical and economic feasibility of the disposal of composted NC fines has been completed. A pilot demonstration of composting NC fines must be performed. A suitable site will be needed for this pilot demonstration.

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Available Documentation

Technical report, *Engineering/Cost Evaluation of Options for Removal/ Disposal of NC Fines,* USATHAMA Report AMXTH-TE-CR-87134, September 1987.

Technical report, *Field Demonstration-Composting of Propellants Contaminated Sediments at the Badger Army Ammunition Plant (BAAP),* USATHAMA Report CETHA-TE-CR-89061, March 1989.

Technical report, *Process and Economic Feasibility of Using Composting Technology to Treat Waste Nitrocellulose Fines,* USATHAMA Report CETHA-TE-CR-91012, March 1991.

Development and Improvement of Analytical Methodology for Environmental Samples Contaminated with Chemical Agents

Purpose

To provide the Army with improved methodology for the low-level analysis of environmental samples possibly contaminated with CW agents:

- GB (Sarin) — Isopropyl methylphosphonofluoridate
- HD (Mustard) — 2,2'-dichlorodiethyl sulfide
- VX — O-ethyl-S-(2-diisopropylaminoethyl) methylphosphonothiolate

Also, to ensure the Army that adequate and accurate methods exist for the primary degradation products, precursors, and other indicator compounds.

Background

The U.S. Army Environmental Center (USAEC) has been tasked to identify and clean up contaminants found on or near Army installations. Some of these contaminants result from past or continuing manufacturing, testing, storing and disposing of munitions containing chemical warfare agents. Soil and groundwater near these operation sites may contain chemical warfare agents and their degradation products.

Limitations

The U.S. Army Chemical Demilitarization Agency has not defined the detection levels of Chemical Warfare Agents (CWAs) in matrices of soil and CWAs in sludge. Until the agency sets these detection levels, USAEC cannot award this contract.

Applicability

This project applies to the Restoration pillar and addresses the following Army Requirements Statements:

- A.1.1 Develop Improved Field Analytical Techniques (1.1.a)
- A.1.9 Standard Analytical Methods for Army-Unique Compounds (1.1.i)
- A.1.13 Organics in Groundwater (1.2.b)
- A.1.24 Determine Natural Attenuation Rates of Army-Unique Compounds (1.3.h)
- A.1.38 Chemical Warfare Material Fate/Transport Prediction (1.5.a)

Performance Needs

Collaboration with U.S. Army Corps of Engineers, Huntsville Division.

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Development and Validation of a Laboratory Compost Treatability Protocol for Explosives-Contaminated Soil

Purpose

To develop a verifiable treatability protocol to determine the applicability of composting quickly and cheaply. The protocol would significantly save costs for the Army.

Background

Composting has become a cost-effective alternative for the U.S. Army Environmental Center (USAEC) to clean up soils containing TNT, RDX, and HMX. The remediation cost depends on several factors, including type and level of contamination, available organic amendments, and type of composting system.

Description

A laboratory reactor has been designed and constructed for conducting compost laboratory studies of soils containing TNT, RDX, and HMX. The reactor can replicate the full-scale composting system previously demonstrated at Umatilla Army Depot Activity (UMDA), Ore.

Limitations

Moisture content and amount of explosives in the soil.

Applicability

Applies to the Cleanup pillar, and particularly to any installation considering composting of explosives in soils.

Accomplishments

Under operating conditions necessary to simulate the UMDA study, a contractor has completed testing soils from two Army installations.

Performance Needs

Data on the breakdown products of TNT; protocol enhanced for RDX and HMX; needs to be obtained through additional contractor laboratory effort.

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Available Documentation

Final Report. Laboratory Scale Compost Treatability Protocol for Explosives Contaminated Soils, SFIM-AEC-ET-CR-96141. November 1995.

Ecological Risk Assessment

Purpose

To provide guidance on procedures for risk assessors to conduct ecological risk assessments under contract to the U.S. Army Environmental Center (USAEC) at Army sites on the National Priorities List (NPL) or part of the Base Realignment and Closure program.

Background

An ecological risk assessment (ERA) uses available chemical, toxicological, and ecological information to estimate the probability of undesirable ecological effects. It also systematically balances and compares risks associated with environmental problems. More specifically for the Superfund program, an ERA refers to a quantitative or qualitative appraisal of the actual or potential impacts of a hazardous waste site on plants and animals, other than humans and domesticated species. A risk does not exist unless:

1) The stressor has the ability to cause one or more adverse effects.
2) It occurs with or contacts an ecological component long enough and at sufficient intensity to evoke the identified adverse effect.

The U.S. Environmental Protection Agency's (EPA) guidance for the conduct and preparation of ERAs has not been very definitive and leaves much room for interpretation. The USAEC initiated, authorized and funded a cooperative effort between ecologists of the Edgewood Research, Development, and Engineering Center (ERDEC), the U.S. Army, and environmental researchers at Clemson University's Institute of Wildlife and Environmental Toxicology to delineate procedures for conducting ERAs.

Description

The report is designed to enhance an understanding of the requirements under the federal Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). This approach will provide USAEC and other document users with cost-effective, tiered procedures to direct and coordinate the scientific and technical efforts of contractors involved in ERA. Use of a common framework across sites will ensure the Army satisfies requirements of state and federal regulators.

Diagram

See Figure 4, Ecological Risk Assessment Framework

Limitations

Possible failure to use the standardized procedural guidelines.

Applicability

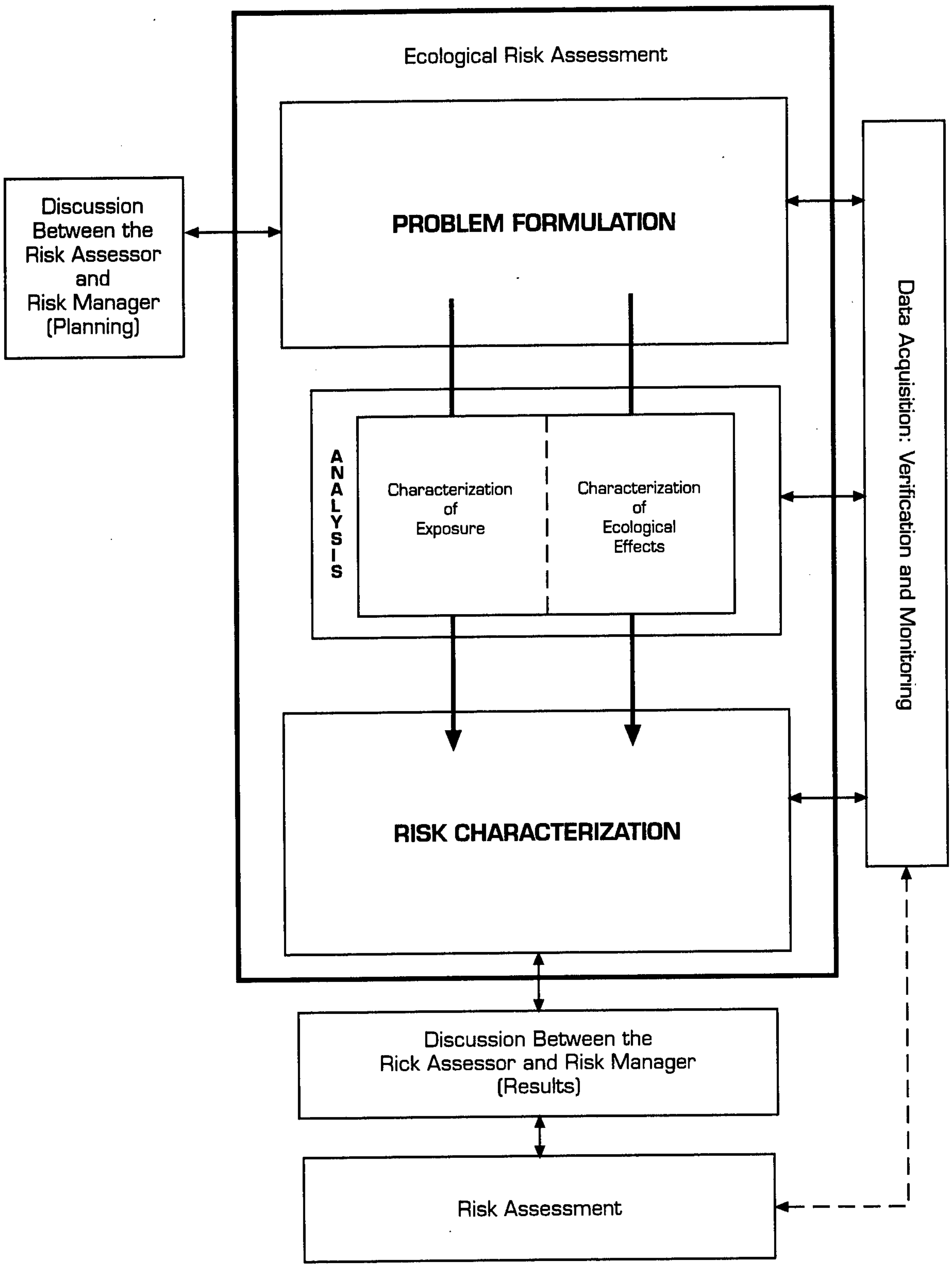
This task or practice applies to the Restoration pillar and aligns with the Cleanup Goals section outlined in the *Andrulis Report*. The Installation Restoration and Base Realignment and Closure programs, through their site project managers, can use this procedural guidance document in the conduct and preparation of ERAs, ensuring consistency, eliminating redundancy, and reducing costs among RI/FS contractors performing ERAs associated with the remediation of Army NPL sites.

Accomplishments

ERDEC prepared and published a two-volume guidance document, *Procedural Guidelines for Ecological Risk Assessments at U.S. Army Sites,* in December 1994 as a Technical Report (ERDEC-TR-221) to satisfy the stated need.

FIGURE 4

ECOLOGICAL RISK ASSESSMENT FRAMEWORK



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AVAILABLE DOCUMENTATION

Volumes I and II, *Procedural Guidelines for Ecological Risk Assessments at U.S. Army Sites,* ERDEC-TR-221.

Ecological Toxicity Assessment

Purpose

To provide environmental toxicity information on hazardous chemicals for use in ecological risk assessments in the cleanup of Army sites on the National Priorities List (NPL).

Background

In collaboration with the Environmental Sciences Division at Oak Ridge National Laboratory (ORNL), environmental toxicologists in the Health Sciences Research Division continue to develop ecotoxicological benchmarks for hazardous chemicals. These benchmarks serve as screening tools to determine the potential hazard of a contaminant to representative aquatic and terrestrial species. In FY 1995, the U.S. Army Environmental Center (USAEC) tasked ORNL to provide these benchmarks and pertinent ecotoxicological data to support the Installation Restoration Program (IRP) and RI/FS contractors in performing ecological risk assessments. Moreover, in the late 1980s, the U.S. Army Biomedical Research and Development Laboratory (USABRDL) tasked ORNL to derive water-quality criteria for several munitions compounds. For this task, ORNL also is updating these criteria and deriving additional criteria for other chemicals of interest to IRP remediation projects. This task should help to fill some of the many data gaps and uncertainties associated with ecological risk assessments, as well as ensure consistency and reduce redundancy.

Description

ORNL is preparing Ecological Criteria Documents for chemicals of interest to IRP remediation projects, which include data on environmental fate, aquatic toxicity, terrestrial toxicity, regulatory criteria, and derivation of benchmarks and criteria, when possible. The Executive Summary is designed for direct inclusion in ecological risk assessments. Staff expertise includes 10 mammalian and environmental toxicologists; five are Diplomates of the American Board of Toxicology. Another new initiative under this task, exposure pathway modeling for terrestrial systems, also is a collaboration with ESD at ORNL.

Diagram

See Figure 5, Toxicity Summaries - Army

Applicability

This task or process applies to the Restoration pillar and aligns with Cleanup Goals, as outlined in the *Andrulis Report*. The Installation Restoration Program, through its site project managers, and staff in the Center for Health Promotion and Preventive Medicine (CHPPM) can use ORNL's documentation of ecotoxicological data, derivation of screening benchmarks and cleanup criteria, and exposure modeling to ensure consistency and reduce redundancy among RI/FS contractors performing risk assessments associated with the remediation of Army NPL sites.

Accomplishments

ORNL is providing USAEC with Ecological Criteria Documents for eight chemicals of interest in FY 1995.

Figure 5

Toxicity Summaries - Army

Completed		In Progress	To Be Completed in FY '96 - '97
Acenaphthene	Fluoranthene	Phenol	Chloride
Acenaphthylene	Fluorene	Polychlorinated biphenyls	DDT/DDE/DDD
Acetone	Indeno(1,2,3-c,d)pyrene	1,1,2-Trichloroethane	1,4-Dichlorobenzene
Aluminum	HMX		Dieldrin
2-Amino-4,6-dinitrotoluene	Lead		Di-*N*-butyl phthalate
2-Amino-4-nitrotoluene	Manganese		Ethylbenzene
4-Amino-2-nitrotoluene	Methyl isobutyl ketone		Fluoride
Anthracene	Mercury		Heptachlor
Antimony	Methyl mercury		Heptachlor epoxide
Arsenic	Molybdenum		α-Hexachlorocyclohexane
Barium	Napthalene		β-Hexachlorocyclohexane
Benzene	Nickel		γ-Hexachlorocyclohexane
Benz[*a*]anthracene	Nitrates		Nitrite
Benzo[*a*]pyrene	Nitrobenzene		Radium-226 & -228
Benzo[*b*]fluoranthene	Pentachlorophenol		Sodium
Benzo[*g,h,i*]perylene	Phenanthrene		1,1,2,2-Tetrachloroethane
Benzo[*k*]fluoranthene	Pyrene		
Beryllium	RDX		
Bis[2-ethylhexyl]phtalate	Selenium		
Bromoform	Silver		
Cadmium	Strontium-90		
Carbon tetrachloride	Sulfates		
Chlordane	Tetrachlorethylene		
Chloroform	Tetryl		
Chrysene	Thallium		
Chromium VI & Total	Toluene		
Copper	1,1,1,-Trichloroethane		
Cyanide	Trichloroethylene		
Dibenz[*a,h*]anthracene	1,3,5-Trinitrobenzene		
1,1-Dichloroethane	2,4,6-Trinitrotoluene		
1,2-Dichloroethane	Vanadium		
1,1-Dichloroethylene	Vinyl chloride		
cis - & *trans*-1,2-Dichloroethylene	Xylene		
Dichloromethane	Zinc		
Diethyl phthalate			
1,3-Dinitrobenzene			
2,4-Dinitrotoluene			
2,6-Dinitrotoluene			

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Available Documentation

All Ecological Criteria Documents are provided in hard copy and electronic form to the USAEC contracting officer's representative, Robert Muhly, for internal review and dissemination to concerned parties.

Energetics-Contaminated Equipment

Purpose

To develop hot gas technology to allow cost-effective decontamination of internal and external surfaces contaminated with energetic materials.

Background

The manufacturing, handling, and loading of explosives at Army ammunition plants contaminates process equipment — such as pumps, tanks, and piping — with explosive residue. This contamination prevents maintenance and repair of the equipment and its reuse or disposal as scrap. Many metal munition items, such as projectiles and mine casings, from which explosives have been removed by washout, meltout, or auguring out, also require additional decontamination to 5X standards to dispose of them properly.

Pilot tests and studies completed by Roy F. Weston Inc. in 1990 at Hawthorne Army Ammunition Plant (HWAAP), Nev., demonstrated the decontamination of metal components by heating them with a circulating hot gas. The gas volatilizes the explosives and destroys them in a high-temperature thermal oxidizer. These tests indicated metal items contaminated with TNT and treated for six hours at a minimum temperature of 500 degrees Fahrenheit characteristically are not hazardous and may be discarded appropriately or resold as scrap. The HWAAP hot gas system was redesigned, based upon recommendations from the demonstration.

Description

The Tennessee Valley Authority (TVA), under contract to the U.S. Army Environmental Center (USAEC), began further testing of the Hot Gas Decontamination (HGD) at HWAAP from June through October 1994. The testing demonstrated successful removal efficiencies of 99.99 percent or greater for items contaminated with the following explosives at the test conditions:

- RDX (3-inch and 5-inch projectiles), Comp A-3 (106-mm projectiles), TNT (3-inch projectiles), and Comp B (175-mm projectiles) at 550° F for six hours.
- HBX (3-inch projectiles) at 600° F for six hours.
- Yellow D, ammonium picrate (3-inch and 5-inch projectiles) at 600° F for six hours. (The process required six additional hours to remove a group of unidentified by-products, yet to be determined as hazardous).
- Explosives held in a tar-like hot melt sealant (common to naval munitions) at 700° F for 24 to 32 hours. The test required this temperature and hold time to volatilize both the hot melt and the explosive, a condition imposed when researchers found the hot melt would dissolve and retain the explosives when heated while in contact with explosive residue. Test items coated with hot melt were contaminated with HBX (MK54 depth bomb) and TNT (MK25 naval mine).

DIAGRAM

See Figure 6, Process Flow Diagram

LIMITATIONS

Bulk energetics, piping or process equipment with gross energetic contamination (i.e., visible chunks) that have not undergone any washdown because of potential detonation hazards.

APPLICABILITY

This technology applies to any piping or process equipment with internal surfaces or parts difficult to decontaminate with physical methods, or surfaces that would retain contaminants even after a surface decontamination. Tests show the technology effectively decontaminates buildings and other large structures, such as ton containers, and concrete and steel structures contaminated with mustard agent.

When the U.S. Army Defense Ammunition Center and School (USADACS) establishes new standards for decontamination (5X), this technology will provide an alternative to flaming at 1000 F for 15 minutes so the government can release items from its control and allow the potential reuse or disposal of these items as scrap instead of discarding them in a hazardous waste landfill.

ACCOMPLISHMENTS

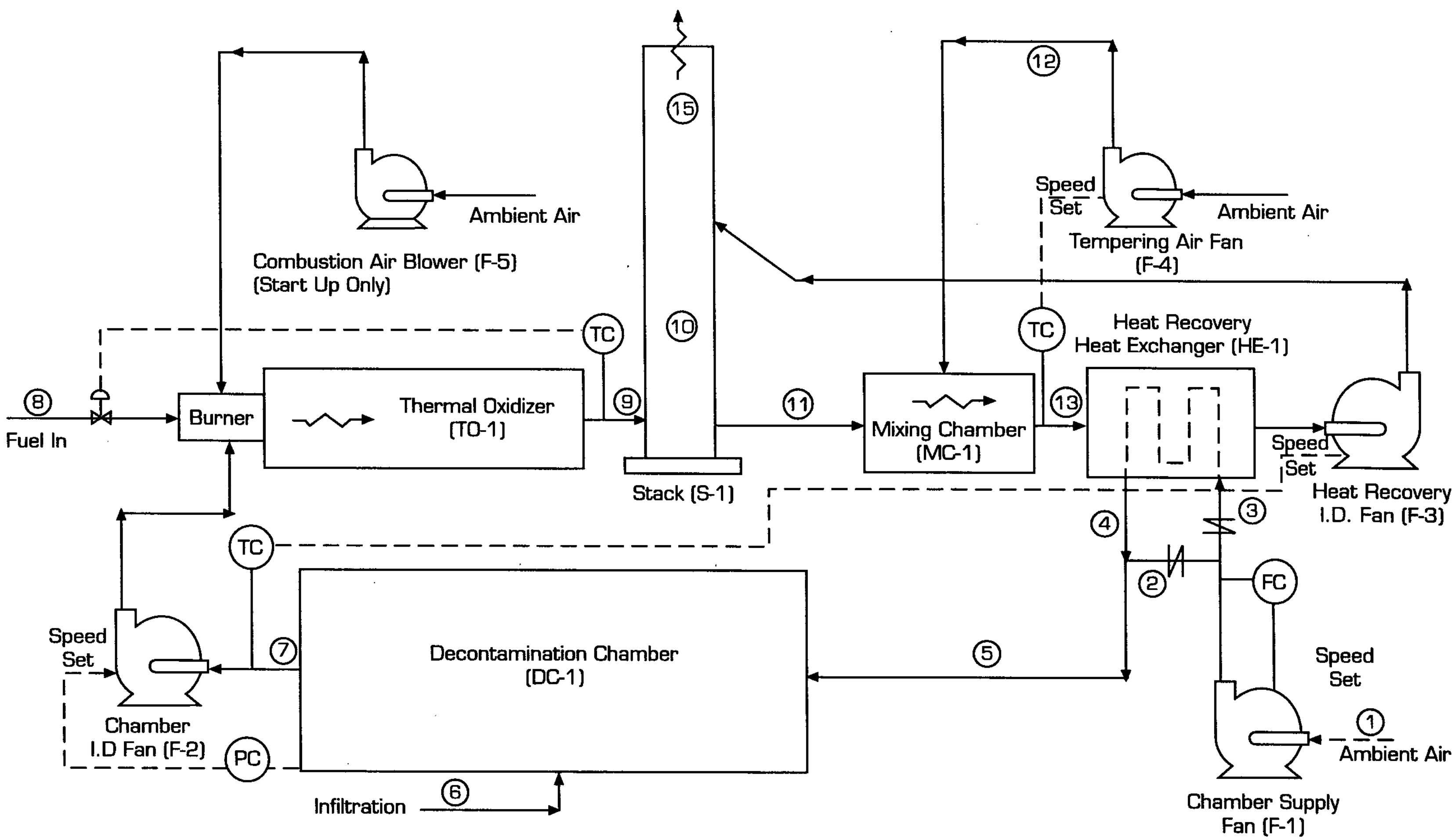
- Prepared test plan for the HWAAP system (August 1993 to March 1994);
- Developed methods for spiking, sampling, and analyzing explosives (January to May 1994);
- Conducted 34 tests at HWAAP (June to November 1994);
- Prepared a conceptual design package for a new facility and retrofitting the Chemical Waste Processor (CWP) based on data from HWAAP tests (August 1993 to November 1994);
- Continued discussions with Iowa Army Ammunition Plant to modify its CWP to a HGD/CWP retrofit (March to July 1995);
- Continued discussions with Milan Army Ammunition Plant, Tenn., (which plans to install a CWP in FY 1997) to evaluate the possible use of HGD technology instead of standard CWP (June to August 1995);
- Developed a cost estimate for constructing a laboratory and bench-scale HGD system of 1 cubic meter at TVA, Muscle Shoals, Ala., to devise the most-effective process, refine the understanding of the destruction mechanism, develop process control systems, obtain data on an expanded number of explosives, and perform various treatability studies for installations interested in the transfer of the technology (June to August 1995).

PERFORMANCE NEEDS

Identify installations with an abundance of energetics-contaminated piping or sewer lines, process equipment, buildings, large containers (such as 1-ton containers), and other equipment contaminated by energetics during installation restoration or base closure activities. Determine which installations have interest in the potential transfer of HGD technology or modification of their CWPs.

Figure 6

Process Flow Diagram



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AVAILABLE DOCUMENTATION

Technical report, *Development of Novel Decontamination and Inerting Techniques for Explosives-Contaminated Facilities, Phase 1 —Identification and Evaluation of Novel Decontamination Concepts,* USATHAMA Report DRXTH-TE-CR-83211, July 1983.

Technical report, *Development of Novel Decontamination and Inerting Techniques for Explosive-Contaminated Facilities, Laboratory Evaluation of Novel Explosives-Decontamination Concepts,* USATHAMA Report AMXTHE-TE TR-85009, March 1985.

Technical report, *Design Support for a Hot Gas Decontaminating System for Explosives-Contaminated Buildings,* Maumee Research and Engineering, April 1986.

Technical report, *Pilot Plant Testing of Caustic Spray/Hot Gas Building Decontamination Process,* USATHAMA Report AMXTH-TE-CR-87112, August 1987.

Technical report, *Task Order 2, Pilot Test of Hot Gas Decontamination of Explosives-Contaminated Equipment at Hawthome Army Ammunition Plant (HWAAP),* Hawthorne, Nevada, USATHAMA Report, June 1990.

Technical report, *Hot Gas Decontamination of Explosives-Contaminated Items, Process and Facility Conceptual Design,* USAEC Report SFIM-AEC-ET-CR-94118, January 1995.

Technical report, *Field Demonstration of the Hot Gas Decontamination System,* USAEC Report SFIM-AEC-ET-CR-95011, February 1995.

Technical report, *Demonstration Results of Hot Gas Decontamination for Explosives at Hawthome Army Depot,* USAEC Report SFIM-AEC-ET-CR-95031, September 1995.

Cost Report: Windrow Composting to Treat Explosives-Contaminated Soils at Umatilla Army Depot Activity (UMDA)

Purpose

To prepare a cost and performance report from data developed during the remediation of the explosives-contaminated lagoon soils at Umatilla Army Depot Activity (UMDA), OR, using composting.

Background

The manufacture of explosives; the load, assemble, and pack of explosives into munitions; and the demilitarization of munitions produced large quantities of wastewater discarded in lagoons. Laboratory tests and field demonstrations have proven composting of explosives-contaminated soil as an acceptable technology for treating explosives-contaminated soil more cheaply than incineration.

Description

The approach in this project includes collecting cost and performance data from the remediation activities at UMDA and reporting these costs in individual elements for composting of explosives-contaminated soil.

Diagram

See Figure 7, Remediation of the UMDA Washout Lagoon Soil by Windrow Composting

Applicability

Composting technology applies to any site with explosives in the soil. This cost and performance report will help site managers determine if composting is economical for a particular site.

Accomplishments

Since the project began in May 1995, data collection has begun at the U.S. Army Corps of Engineers, Seattle District, Fort Lewis Area Office, which manages the composting effort at UMDA. The final report is due in August 1996.

Performance Needs

The major need is collecting and segregating costs to individual elements in the composting operations at UMDA.

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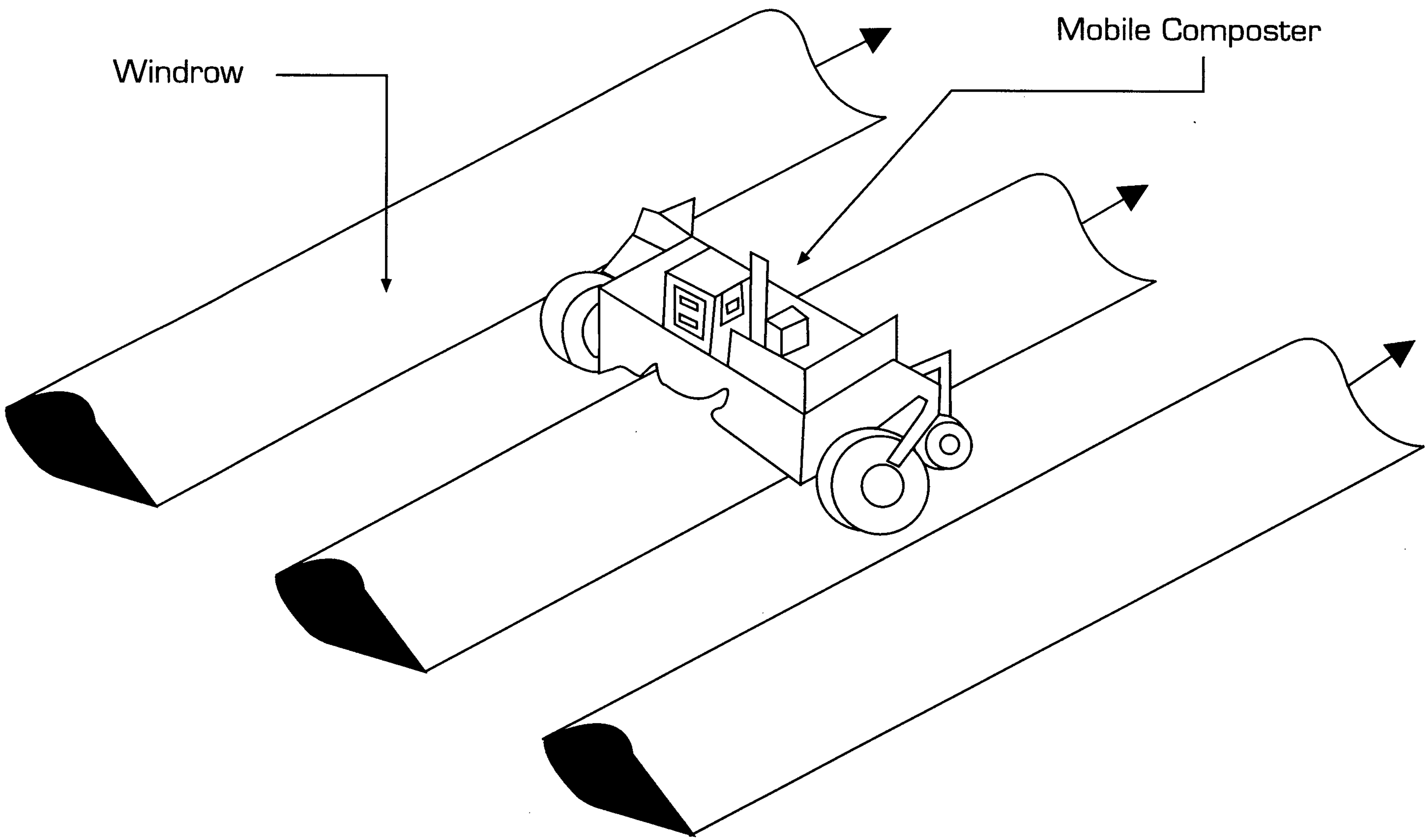
Available Documentation

Guide to Documenting Cost and Performance for Remediation Projects, EPA-542-B-95-002, March 1995.

Figure 7

Remediation of the UMDA Washout Lagoon by Windrow Composting



Environmentally Redesigned Small-Arms Ranges

Purpose

To evaluate new firing-range technologies that allow the effective capture and recycling of projectiles with minimal contamination of soil and that eliminate rainwater infiltration and runoff.

Background

Numerous Army installations contain firing ranges for small-arms training, and many of them have been used since World War II. These ranges contain impact berms, or bullet traps, that are engineered piles of soil or hillsides. None of these ranges was designed to allow recovery of the lead projectiles or prevent the leaching of lead into the groundwater.

Description

This project addresses only the redesign of berms and not all aspects of firing ranges. To prevent future contamination of firing range sites, it will use new technologies, such as chemical or physical fixation techniques, to allow recovery of lead projectiles while minimizing the lead-smear problem. It also will help control soil erosion and allow removal and disposal of contaminated impact material. Future ranges should prevent rainwater infiltration and leaching of lead to surface runoff and into groundwater.

Limitations

Project addresses only the redesign of berms and not all aspects of firing ranges.

Applicability

This project applies to the Pollution Prevention and Restoration pillars. The Army Requirements Statements addressed include:

Pollution Prevention

- A.3.3 Heavy Metals Reduction/Elimination from Surface Protection Processes (3.1.c)
- A.3.18 Reduce Hazardous Components in Ordnance (3.3.d)
- A.3.23 Eliminate Lead in Ordnance (3.3.d)

Restoration

- A.1.3. Cleanup Goals (1.1.c)
- A.1.32 Heavy Metal (1.4.c)
- A.1.33 Lead Contamination (1.4.c)

Accomplishments

The main contractor for this project is TRW/Test and Evaluation Engineering Services (TEES), and demonstration site chosen is Fort Rucker. Subcontractors are submitting technology proposals for evaluation.

Performance Needs

Collaboration with U.S. Army Corps of Engineers Waterways Experiment Station (WES) and the U.S. Army Corps of Engineers, Huntsville Division.

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Extraction and Chromatographic Development of Selected Organophosphorus Compounds from Soil and Aqueous Media

Purpose

To develop and evaluate a potential fate model to assess whether alkylmethylphosphonates arising from chemical surety material (CSM) and sources unrelated to CSM are present and when introduction occurred to the environment.

Background

The U.S. Army Environmental Center (USAEC) has been tasked to identify and clean up contaminants found on or near Army installations. Some of these contaminants result from past or current manufacturing, testing, storing, and disposing of munitions containing chemical warfare agents. Soil and groundwater near these operation sites may contain chemical warfare agents and their degradation products.

Description

Four alkylmethylphosphonates — pinacolyl methylphosphonate (PMPA), isopropyl methylphosphonate (IMPA), ethylmethylphosphonate (EMPA), and methylphosphonate (MPA) — have long been used as surrogate compounds to detect phosphonofluoridate nerve agents in environmental media. This project has developed an ion chromatographic method that successfully separates all four alkylmethylphosphonates in a single run on a solvent compatible ion-exchange column.

While ion exchange is the principal retention mechanism, reversed-phase selectivity provides the required separation. This method requires only minimal sample preparation and was applied to both surface and ground waters using both spiked and authentic samples.

Limitations

Must be applied to a full range of degradation products. (This list of products must be determined.)

Applicability

This project applies to the Restoration pillar. The Army Requirements Statements addressed include:

- A.1.1 Develop Improved Field Analytical Techniques (1.1.a)
- A.1.9 Standard Analytical Methods for Army-Unique Compounds (1.1.i)
- A.1.13 Organics in Groundwater (1.2.b)
- A.1.24 Determine Natural Attenuation Rates of Army-Unique Compounds (1.3.h)
- A.1.38 Chemical Warfare Material Fate/Transport Prediction (1.5.a)

Accomplishments

This project has developed a novel method for the simultaneous determination of PMPA, IMPA, EMPA, MPA, DMMP, DEMP, DIMP, Glyphosate, Dequest 2010, Dequest 2041 and Dequest 2051. Researchers have achieved this determination in water and extended it to a variety of characterized soils. Because of this work, USAEC no longer uses Method AAA9 (for methylphosphonic compounds). The following two methods superseded it:

1) Pinacolyl Methylphosphonic Acid, Isopropyl Methylphosphonic Acid, Ethyl Methylphosphonic Acid, and Methlphosphonic Acid in water.

2) Pinacolyl Methylphosphonic Acid, Isopropyl Methylphosphonic Acid, Ethyl Methylphosphonic Acid, and Methlphosphonic Acid in Soil.

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Available Documentation

Technical report, *Extraction and Chromatographic Development of Selected Organophosphorus Compounds from Soil and Aqueous Media,* U.S. Army Report TCN 914229, October 1993.

Technical report, *Environmental Fate of Alkyl Methylphosphonates Arising from Chemical Surety Material (CMS) and Potential Non-CSM Sources in Soil and Aqueous Media,* U.S. Army Report TCN 91429, March 1994.

Field Deployable, Direct Sampling Ion Trap Mass Spectrometer

Purpose

To commercialize and market a field-portable, continuous monitoring mass spectrometer.

Background

Past manufacturing, handling, and disposal of hazardous materials at Department of Defense (DoD) facilities have resulted in the contamination of soil and water. Current methods for characterizing contaminated sites are costly and time-consuming. Traditional site characterization includes drilling, sampling, and shipping the samples to a laboratory for analysis. Researchers repeat these steps as necessary to fill in data gaps. The process can take weeks, months or years to complete.

To analyze water and soil samples with a high degree of certainty, traditional laboratories use mass spectrometry. Traditional laboratory analysis usually takes a week to 40 days to complete after sample receipt. A portable, direct sampling ion trap mass spectrometer (DSITMS) can reduce the time needed to get accurate analyses and increase the number of samples analyzed. As a field tool, the system reduces the expense of sending samples to a laboratory because it identifies the extent of site contamination in near real-time.

Description

The DSITMS uses an ion trap mass spectrometer to continuously and simultaneously monitor multiple analytes as they are introduced into the ion trap. No (or minimal) sample preparation or chromatographic separations are required. The process uses multiplexed ionization, selective ionization and detection, and multiple stage mass spectrometry to distinguish between analytes. Split vent sampling is used to collect excess samples to validate with traditional methods.

Two key elements make the DSITMS unique. The rugged ITMS enables the instrument to function under adverse field conditions, without access to a power source, for up to eight hours. Also, the sampling interfaces allow liquid and gaseous samples to be introduced to the instrument without prior sample preparation.

Diagram

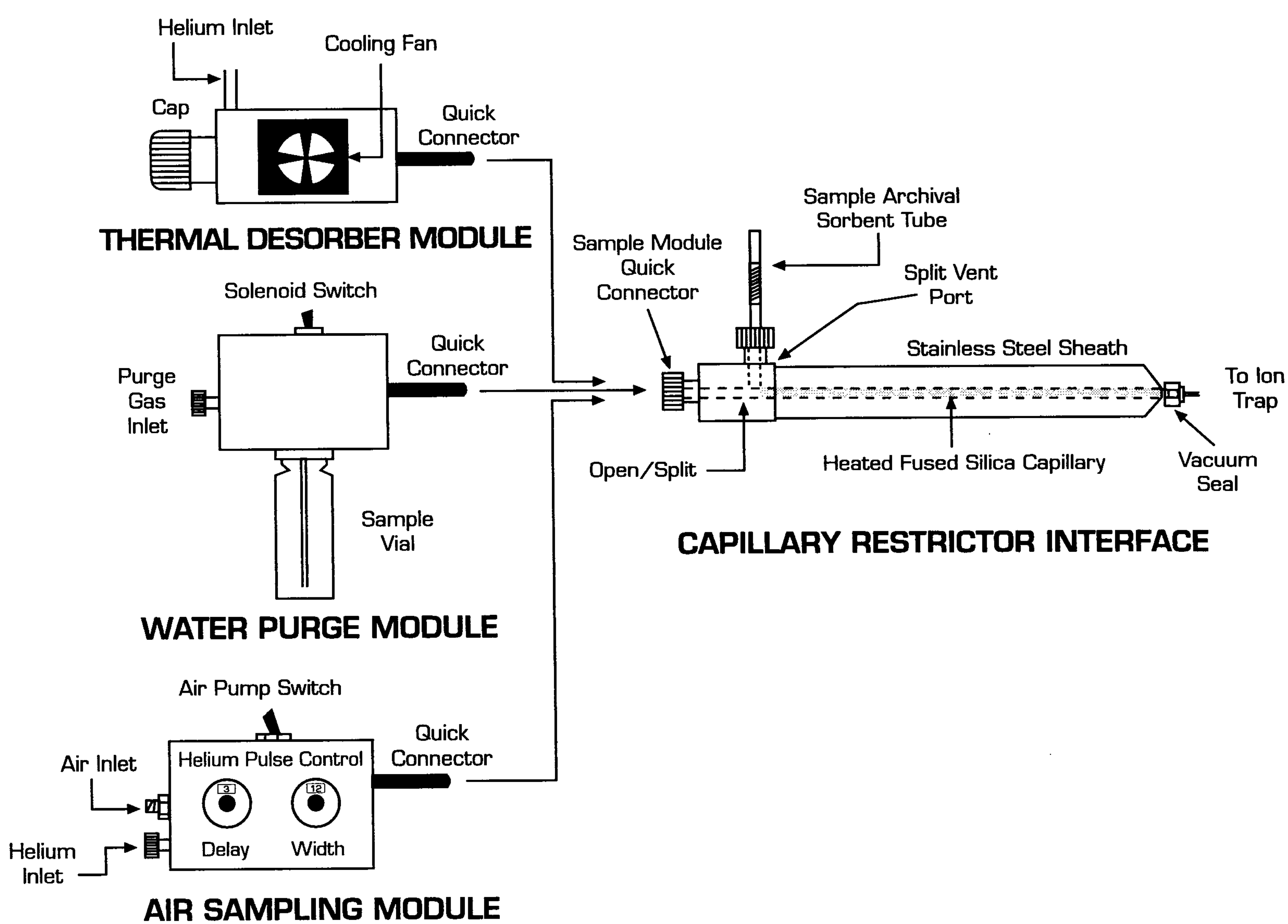
See Figure 8, Field Deployable Direct Sampler

Limitations

DSITMS needs regulatory acceptance and field implementation.

Figure 8

Field Deployable Direct Sampler



Applicability

DSITMS applies to the following Army Requirements Statements:

- A.1.1 Develop Improved Field Analytical Techniques (1.1.a)
- A.2.14 Monitoring of Waste Streams at Industrial Waste Treatment Plants (2.2.h)
- A.2.1 Volatile Organic Compound (VOC) Emission Control (2.1.a)
- A.2.6 Hazardous Air Pollutant (HAP) Emission Control (2.1.g)
- A.2.3 Monitoring Air Emissions (2.1.c)
- A.3.46 Rapid Field Sample Analysis (3.7.f)

Accomplishments

- Laboratory and field studies using volatile organic compound (VOC) mixtures have shown quantities below 10 ppb, in turnaround times of several minutes.
- The DSITMS has been successfully field tested at various DoD and Department of Energy (DoE) sites.
- The Environmental Protection Agency (EPA) assigned an SW-846 field method number for the DSITMS volatile organic compound methods of analysis.
- The ITMS has been operated in conjunction with the Site Characterization and Analysis Penetrometer System (SCAPS) for the characterization of sites contaminated with VOCs.
- Teledyne Inc. leads a consortium of private companies and Oak Ridge National Laboratory that secured funding through the Advanced Research Programs Agency for matching funds to commercialize and market the DSITMS.
- Teledyne Inc. has produced seven prototype DSITMS instruments, which are currently being evaluated by members of the consortium. The second series of prototypes will incorporate the comments from the users and will be available for field evaluations in April 1996.
- One prototype is being evaluated as part of the EPA program, "Consortium for Site Characterization Technologies (CSCT)."

Performance Needs

The Army will receive six instruments over three years, and needs funding to evaluate the performance and application of the DSITMS to DoD user requirements.

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AVAILABLE DOCUMENTATION

Comparison of Direct Sampling Ion Trap Mass Spectrometry to GC/MS for Monitoring VOCs in Groundwater, proceedings of the 4th International Field Screening Symposium, Las Vegas, Nev., February 1995.

Effects of Transfer Line on the MS Sampling and Analysis of VOCs in Air, Proceedings from the 43rd ASMS Conference on Mass Spectrometry, Atlanta, Ga., May 1995.

Real-Time Continuous Monitoring of VOCs by Direct Sampling Ion Trap Mass Spectrometry, Proceedings of the 3rd International On-Site Analysis Conference, Houston, Texas, January 1995.

Enhanced Sensitivity Real-Time Monitoring of VOCs in Air and Water Using Filtered Noise Field in Conjunction with a Direct Sampling Ion Trap Mass Spectrometer, proceedings from the 42nd ASMS Conference on Mass Spectrometry, Chicago, Ill., May 1994.

Field Transportable Ion Trap Mass Spectrometer, proceedings of the IFPAC ON-SITE Conference, Houston, Texas, January 1994.

"Direct Sampling Ion Trap Spectrometry," *Spectroscopy Magazine,* April 1993.

Rapid Environmental Organic Analysis by Direct Sampling Glow Discharge Mass Spectrometry and Ion Trap Mass Spectrometry: Summary of Pilot Studies, USATHAMA Report, CETHA-TE-CR 90029.

Field Portable Instrumentation X-Ray Fluorescence

Purpose

To determine the availability and effectiveness of field-portable instrumentation for the determination of metals Cu, As, Hg, and Pb. The instrumental detection limits range from 4 ppm to 42 ppm for metals in water and from 10 ppm to 60 ppm for metals in soil.

Background

Current methods of analyzing metals require sending samples to a laboratory.

Description

In the field, this system achieves reasonable quantitative results for wet soil and water contaminated in the 100 to 300 ppm range. Doing the analysis in the field saves time and shipping costs.

Accomplishments

Researchers conducted laboratory and bench testing at Oak Ridge National Laboratory and trial field tests at Rocky Mountain Arsenal, CO. After they examined various configurations of instruments and detectors, they selected the instrument that best meets the requirements of operating in the field, selectivity, and sensitivity, and evaluated its performance in the screening for hazardous waste metals in soils. They will test different equipment at installation restoration sites for data collection and comparison purposes.

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Field Sample Preparation

Purpose

To develop techniques to prepare field samples of common environmental contaminants.

Background

Handling groundwater and soil samples currently requires collecting an appropriate sample, adding the proper preservative, and shipping to an environmental laboratory for analysis. Recent research and development programs run by the Army have stressed the importance of field analytical instrumentation as a feasible alternative to shipping samples to an environmental laboratory. The samples, however, often have to be prepared for analysis using the same techniques found in the laboratory.

Description

Proper preparation of field samples can eliminate the inherent loss of compounds that occurs as they are prepared for shipment and analysis. Researchers must use more efficient, cost-effective, and timely procedures so field teams can determine quickly which samples are contaminated.

Accomplishments

Researchers have developed and manufactured new sample containers for collecting volatiles and demonstrated technology at one site. With additional comparisons to conventional methodology, they demonstrated they can enhance the recovery of volatiles. They also demonstrated a way to prepare a sample to evaluate performance.

Performance Needs

Researchers will apply the technology at additional sites to demonstrate how the methodology applies. Additional efforts will focus on a demonstration of procedures to enhance the preservation of soil containing volatile organic compounds (VOCs) and to establish the efficiency of a sample to evaluate performance for soil volatiles.

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AVAILABLE DOCUMENTATION

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Hazardous Waste Minimization Technology Transfer/ Implementation Support for Depot System Command Installation

Purpose

Cadmium electroplating, a significant source of hazardous waste at Army industrial operations, is applied to many metal parts to protect surfaces. Aluminum Ion Vapor Deposition (AIVD), a surface-plating technology, applies a coating of aluminum. However, it does not generate hazardous waste. It also reduces employee exposures to cadmium and provides corrosion protection. Letterkenny Army Depot (LEAD), Pa., received HAZMIN technical assistance for treatment of methylene chloride contamination in paint-stripping rinse waters.

Background

Since the beginning of the Army Materiel Command's HAZMIN program, the U.S. Army Environmental Center (USAEC) has supported HAZMIN initiatives at all AMC industrial operations. Specific initiatives relating to Initial Operating Capability facilities have included demonstrating and implementing AIVD at Anniston Army Depot, Ala. The objective of the current task is to provide Initial Operating Capability with support for technology transfer and implementation of AIVD at Tobyhanna Army Depot (TOAD), Pa..

Description

Activities have focused on technical support and technology transfer at TOAD to support the evaluation and acquisition of AIVD technology. Work has included preparing economic analyses and equipment bid specifications and providing technology transfer materials.

Limitations

The AIVD coating is not a universal substitute for cadmium. Replacement of current plating technology must be evaluated case-by-case (often for individual parts). Part specifications that require cadmium coatings cannot be substituted for AIVD coatings without approval of the part's owner or manager.

Applicability

The IVD technology potentially applies to all Army industrial operations as a candidate for replacement of cadmium electroplating.

Accomplishments

Researchers have completed economic analysis and bid specification for AIVD at TOAD. They also visited Anniston and Corpus Christi (Texas) Army Depots to observe the operation of existing AIVD systems and discuss acquisition, equipment options and operation, and lessons learned with current operators. They presented technology transfer materials at project briefings and meetings at TOAD, LEAD, and Watervliet Arsenal, N.Y. They also presented draft test and safety plans for characterization of methylene chloride contamination in paint-stripping rinse waters at LEAD; however, they did not implement the plans because of operation changes at the depot (i.e., substitution of a stripper other than methylene chloride).

Performance Needs

Identification of candidate replacement parts at TOAD and definition of the mechanism for approval of AIVD as a substitute coating.

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Available Documentation

Final Report, *Technical Support for Reduction of Methylene Chloride Contamination in Paint-Stripping Rinse Waters at LEAD,* February 1996. Report Number SFIM-AEC-ET-CR-96004.

Final Report, *Technical Support for Implementation of Aluminum Ion Vapor Deposition at Tobyhanna Army Depot,* February 1996. Report Number SFIM-AEC-ET-CR-96006.

Human Health Toxicity Assessment

Purpose

To provide toxicity information on hazardous chemicals for use in toxicity assessments performed as part of human health risk assessments in cleanups of Army sites on the National Priorities List (NPL).

Background

Under contract to the U.S. Environmental Protection Agency (EPA), staff members in the Health Sciences Research Division at Oak Ridge National Laboratory (ORNL) for several years have been preparing chemical-specific documents addressing human health and environmental toxicity. The preparation of these documents includes the derivation of toxicity values for risk assessment, such as reference doses, reference concentrations, and carcinogen slope factors.

ORNL has performed assessments for more than 800 chemicals and, consequently, has amassed an impressive reference library. ORNL also is responsible for developing the EPA Health Effects Assessment Summary Tables (HEAST), which provide these values. As a result of ORNL's primary contributions to risk assessment methods, USAEC tasked ORNL to provide this support to the Installation Restoration Program (IRP). This task has met or exceeded expectations by providing to USAEC-IRP staff and RI/FS contractors the pertinent toxicological data they need to complete site risk assessments successfully. ORNL's ability to provide the IRP with up-to-date, EPA-approved toxicity information ensures consistency and accuracy and reduces redundancy in site risk assessments.

Description

Staff mammalian and environmental toxicologists, five of whom are Diplomates of the American Board of Toxicology, provide the human health toxicity information in two forms: Toxicity Summaries and Toxicity Value Tables. The summaries provide toxicity data related to the derivation of the EPA-approved toxicity values (RfDs, RfCs, and SFs) for each chemical. These values include:

- Pharmacokinetics;
- Subchronic and chronic oral and inhalation toxicity data for humans and animals;
- Oral and inhalation carcinogenicity data for humans and animals;
- Essential information concerning target organs.

The one-page Executive Summary is designed for direct inclusion in the human health risk assessment. Moreover, the summary points out data gaps and identifies available literature to use to derive missing toxicity values. The summaries are revised every year as needed, based on any EPA changes in toxicity values, and are updated every three years by a search of the primary literature to identify any new toxicity studies performed on the chemicals.

The Toxicity Value Tables provide the IRP with the most current EPA-approved toxicity values to ensure consistency and accuracy in site risk assessments. The tables are provided in both electronic and hard copy format and are updated every three years. A initiative for FY 1995 was to provide the IRP with the development of dermal RfD values for chemicals of primary interest to Army Superfund cleanups.

Diagram

See Figure 9, Toxicity Summaries — Army.

Applicability

This task process applies to the Restoration pillar and aligns with Cleanup Goals, as outlined in the *Andrulis Report*. The Installation Restoration Program, through its site project managers, uses ORNL's documentation of current human health toxicity data to ensure consistency and reduce redundancy among RI/FS contractors performing risk assessments associated with the remediation of the Army's NPL sites.

Performance Needs

Continued financial support is needed to obtain and maintain reference material for the chemicals of interest to the IRP's Superfund remediation projects.

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Available Documentation

All human health Toxicity Summaries are provided in hard copy and electronic form to the USAEC contracting officer's representative, Robert Muhly, for internal review and dissemination to concerned parties. Fifty copies of the Toxicity Value Tables are available every three years.

FIGURE 9

TOXICITY SUMMARIES — ARMY

COMPLETED		IN PROGRESS	TO BE COMPLETED IN FY '96 - '97
Acenaphthene	Fluoranthene	Phenol	Chloride
Acenaphthylene	Fluorene	Polychlorinated biphenyls	DDT/DDE/DDD
Acetone	Indeno(1,2,3-c,d)pyrene	1,1,2-Trichloroethane	1,4-Dichlorobenzene
Aluminum	HMX		Dieldrin
2-Amino-4,6-dinitrotoluene	Lead		Di-*N*-butyl phthalate
2-Amino-4-nitrotoluene	Manganese		Ethylbenzene
4-Amino-2-nitrotoluene	Methyl isobutyl ketone		Fluoride
Anthracene	Mercury		Heptachlor
Antimony	Methyl mercury		Heptachlor epoxide
Arsenic	Molybdenum		α-Hexachlorocyclohexane
Barium	Napthalene		β-Hexachlorocyclohexane
Benzene	Nickel		γ-Hexachlorocyclohexane
Benz[*a*]anthracene	Nitrates		Nitrite
Benzo[*a*]pyrene	Nitrobenzene		Radium-226 & -228
Benzo[*b*]fluoranthene	Pentachlorophenol		Sodium
Benzo[*g,h,i*]perylene	Phenanthrene		1,1,2,2-Tetrachloroethane
Benzo[*k*]fluoranthene	Pyrene		
Beryllium	RDX		
Bis[2-ethylhexyl]phtalate	Selenium		
Bromoform	Silver		
Cadmium	Strontium-90		
Carbon tetrachloride	Sulfates		
Chlordane	Tetrachlorethylene		
Chloroform	Tetryl		
Chrysene	Thallium		
Chromium VI & Total	Toluene		
Copper	1,1,1,-Trichloroethane		
Cyanide	Trichloroethylene		
Dibenz[*a,h*]anthracene	1,3,5-Trinitrobenzene		
1,1-Dichloroethane	2,4,6-Trinitrotoluene		
1,2-Dichloroethane	Vanadium		
1,1-Dichloroethylene	Vinyl chloride		
cis - & *trans*-1,2-Dichloroethylene	Xylene		
Dichloromethane	Zinc		
Diethyl phthalate			
1,3-Dinitrobenzene			
2,4-Dinitrotoluene			
2,6-Dinitrotoluene			

Innovative Physicochemical Treatment of Explosives-Contaminated Soil

Purpose

To assess the feasibility of a novel approach to remediation, rendering explosives harmless without significant risk. The goal of this project is to completely mineralize both TNT and the surfactant (SDS).

Background

Many military sites have high levels of explosives in their soil. Among more than 18,500 contaminated military sites, several thousand contain explosives. The National Priorities List (NPL) contains 45 military installations. For example, at the Joliet (IL.) facility, 72 acres are contaminated and TNT concentrations in the soil have been found in excess of 70,000 ppm. This poses risks to the public (through contamination of water supplies) and to cleanup personnel (through potential for detonation during invasive remediation procedures).

Description

The project will use two sequential operations to remove contaminants from soil: removal from the soil matrix followed by conversion to an inactive material. In the first stage, the explosives will be removed from soil through surfactant washing. In the second stage, the explosives will be rendered harmless through oxidation by hydroxyl radicals produced from Fenton's reagent. In field situations, surfactant can be applied through spray irrigation and then, after it has extracted contaminants, it can be removed using extraction wells.

Limitations

To be determined.

Applicability

This technology applies to the Restoration pillar. The Army Requirements Statements addressed include:

- A.1.1 Develop Improved Field Analytical Techniques (1.1.a)
- A.1.9 Standard Analytical Methods for Army-Unique Compounds (1.1.i)
- A.1.3 Cleanup Goals (1.1.c)
- A.1.18 Remediation of Explosives in Soil (1.3.d)
- A.1.20 Explosives/Organic Contaminated Sediments (1.3.c)

Accomplishments

Work continues.

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JOINT SMALL-ARMS RANGE REMEDIATION

PURPOSE

To conduct a full-scale demonstration of physical separation and soil-washing technologies as an effective treatment for lead-contaminated small-arms firing ranges. Researchers will use validated data on the cost and effectiveness of this demonstration with implementation guidance to explain and transfer this technology to users.

BACKGROUND

A true destruction technology does not exist and cannot be developed for lead and heavy metals in soil. Physical separation technologies, however, separate the metals from much or all of the soil containing the metals. Typically, metals concentrate in the fines fraction of soils.

Isolating the fines fraction removes the contaminant metal from most of the soil and significantly reduces the volume of material requiring landfilling or stabilization. Researchers can backfill the clean soil fraction, without further treatment of that fraction required. The metals in the fines fraction, if concentrated adequately, can be recycled completely in a smelter. Such treatment techniques eliminate the hazard and leave no liability for the Department of Defense (DoD). For small-arms firing range sites, researchers plan to concentrate most of the toxic lead for recycling.

DESCRIPTION

This full-scale demonstration of physical separation and soil-washing technologies may provide an effective treatment for lead in small-arms firing ranges. Researchers will use validated data on the cost and effectiveness of this demonstration with implementation guidance to explain this technology to users.

The approach will accelerate the demonstration and transfer of soil separation and washing technologies to clean up small-arms firing ranges. An Army- and Navy-coordinated demonstration effort will begin as the work by the U.S. Army Corps of Engineers Waterways Experiment Station, funded by the Strategic Environmental Research and Development Program (SERDP), ends. The effort will support the data from the SERDP-funded WES project, and WES and the USBM will receive an additional $200,000 for the best-possible process and treatability data.

After the U.S. Army Environmental Center (USAEC) finishes the treatability project, it will demonstrate commercially-available processes. Two vendors will install their equipment and operate it on-site for three to six months, and the Naval Facilities Engineering Service Center (NFESC) will act as the independent evaluator. Researchers will send concentrated wastes to a local smelter for recycling.

Researchers also will collect data on influent and effluent concentrations and detailed energy and mass balances for each stage of the processes, cost of equipment and resources, operational and maintenance costs, and any other pertinent information. A cost/benefit analysis and all information will be in a final report. USAEC and NFESC will try to transfer the soil-separation and washing technology, using the data from this demonstration with developed implementation and design guidelines.

DIAGRAM See Figure 10, Lead Remediation.

LIMITATIONS This process might not treat soils high in clay content or that contain contaminants such as mercury or certain organic compounds.

This technology directly applies to the following Army Requirements Statements:

- 1.3.e Soil Inorganic
- 1.4.c Heavy Metal

Numerous DoD sites contain lead or other heavy metals from use as small-arms testing and training ranges. Small-arms projectiles consist primarily of lead, which is listed as a toxic material under the Resource Conservation and Recovery Act (RCRA). Recent closings of DoD sites have focused attention on the toxic lead build-up at abandoned small-arms ranges, resulting in their classification as solid waste management units. The Army user community has prioritized the problem "Soil Inorganic" as the seventh-highest requirement in environmental restoration research and development.

ACCOMPLISHMENTS Fort Polk, LA., will serve as the site of the demonstration. The treatability study has ended and performers have received contracts. The government has reviewed the first draft reports of the bench scale tests and the first draft of the test plan submitted by each performer and the independent evaluator, respectively.

PERFORMANCE NEEDS By early 1996, researchers began design and preparation of the demonstration site. Two vendors will begin consecutive demonstration of their technologies in September of the same year. Following completion of each vendor's process, all technical and cost issues will be documented in a final report to aid in transferring this technology to the user.

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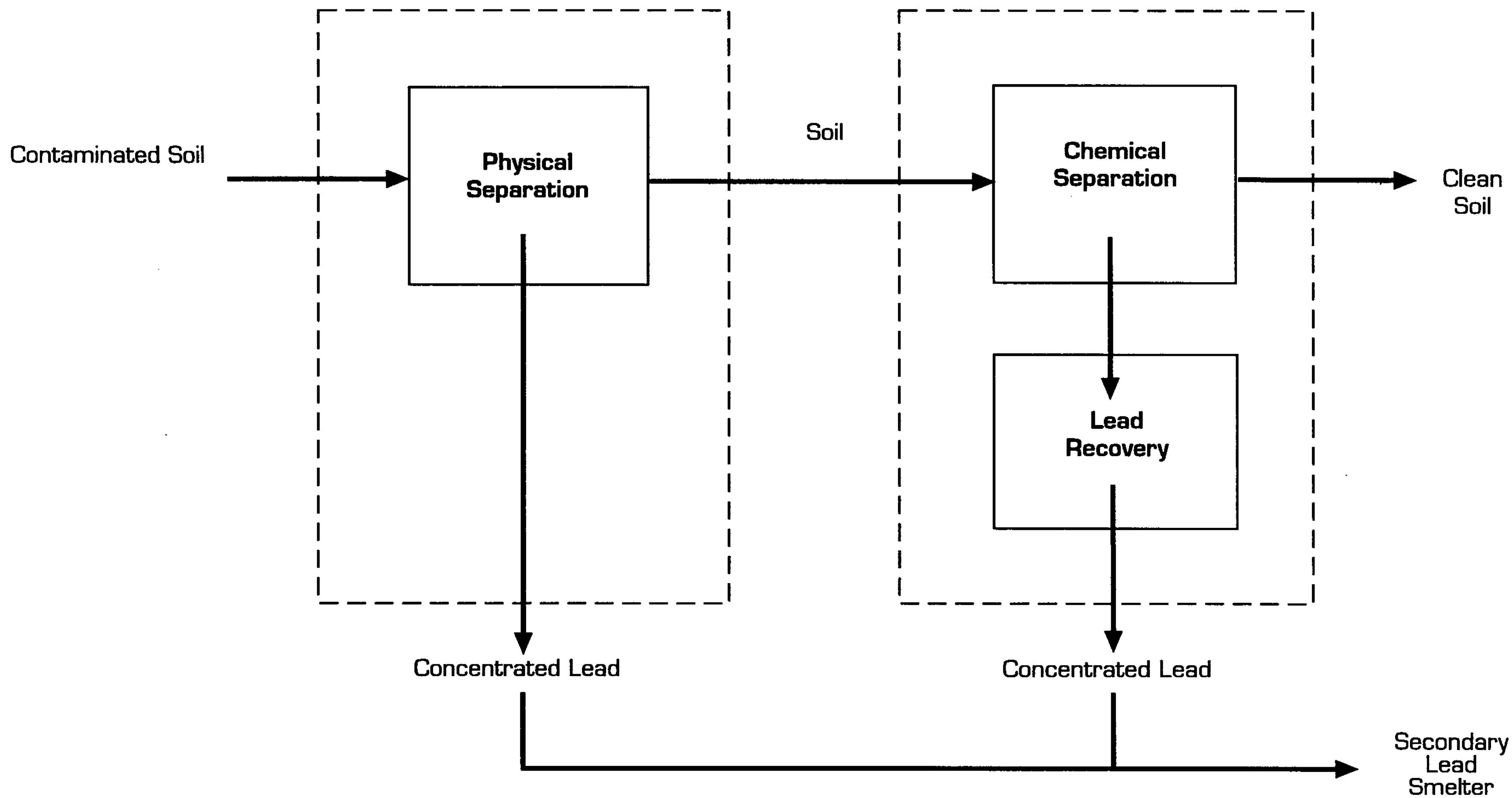
Figure 10

Lead Remediation



Nondestructive Decontamination of Chemical Agent-Contaminated Facilities

Purpose

To develop an innovative, nondestructive technology to clean up Army facilities and equipment containing chemical agents or energetic materials. The cleanup would enable the Army to reuse the equipment or dispose of it as excess.

Background

The Army owns and operates ammunition plants, arsenals, and depots involved in the manufacture, processing, loading, and storage of chemical agents, pyrotechnics, explosives, and propellants. As a result of these operations, buildings and a variety of processing and handling equipment contain chemical agents or energetic materials. Many inactive or standby properties are candidates for excess. Some buildings containing chemical agents or energetic materials have significant potential for reuse or conversion to other uses.

Current decontamination standards require dismantling in a controlled atmosphere, followed by incineration. The technology from this project potentially may decontaminate facilities and equipment cost-effectively and in an environmentally acceptable manner without destroying structural integrity.

Description

This project will provide a safe and effective method of either decontaminating a structure for reuse or rendering it safe for demolition. This project also will help establish analytically based decontamination standards rather than the current operationally based standards.

Accomplishments

A demonstration of the Hot Gas Decontamination System (HGDS) for chemical agent decontamination will be conducted at Rocky Mountain Arsenal, Colo., Building 537. The site has been characterized and system construction is complete.

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AVAILABLE DOCUMENTATION

Technical report, *Development of Novel Decontamination Techniques for Chemical Agents (GB, VX, HD) Contaminated Facilities, Phase I — Identification and Evaluation of Novel Decontamination Concepts,* USATHAMA Report DRXTH-TE-CR-83208, February 1983.

Technical report, *Development of Novel Decontamination and Inerting Techniques for Explosives-Contaminated Facilities, Phase I — Identification and Evaluation of Novel Decontamination Concepts,* USATHAMA Report DRXTH-TE-CR-83211, July 1983.

Technical report, *Development of Novel Decontamination and Inerting Techniques for Explosives-Contaminated Facilities, Laboratory Evaluation of Concepts, Phase II — Laboratory Evaluation of Novel Explosives Decontamination Concepts,* USATHAMA Report AMXTH-TE-TR-85009, March 1985.

Technical report, *Development of Novel Decontamination Techniques For Chemical Agents (GB, VX, HD) Contaminated Facilities, Phase II — Laboratory Evaluation of Novel Agent Decontamination Concepts,* USATHAMA Report AMXTH-TE-TR-85012, June 1985.

Peroxone Treatment of Explosives-Contaminated Groundwater

Purpose

To demonstrate and validate peroxone as a cost-effective method to treat explosives in groundwater. The demonstration is at a scaleable size to document cost information accurately with data on the effectiveness of the process.

Background

Granular-activated carbon (GAC) is the current treatment technology for cleaning up explosives (TNT, trinitrobenzene, RDX, and HMX) in groundwater. An innovative technology, ultraviolet (UV) oxidation, soon will be available for treating explosives in groundwater. UV oxidation processes require relatively expensive and high-maintenance UV lamps to generate hydroxyl radicals from oxidant sources.

Hydrogen peroxide and ozone typically have been the chosen oxidant sources. The hydroxyl radicals oxidize contaminants particularly aggressively and effectively. Fouling of the UV lamps by inorganic groundwater contaminants has plagued the UV oxidation processes.

Research indicates mixing hydrogen peroxide and ozone without UV light also produces hydroxyl radicals, which can oxidize contaminants. This process, peroxone oxidation, is used in several U.S. cities, including Los Angeles, and a number of municipalities in Europe, including Paris, to disinfect drinking water. Eliminating the UV lamps may reduce treatment costs significantly, compared to UV oxidation. The treatment costs at the Paris facility are reported as low as 2 cents/kgal.

Description

This project will provide a full-scale demonstration of peroxone oxidation as an effective treatment of explosives in groundwater. Validated data on the cost and effectiveness of this demonstration and documents explaining how to implement this technology will go to users. Researchers plan to demonstrate a 25-gpm system on two wells at Cornhusker Army Ammunition Plant (CAAP), Neb. Information from this project will be provided to the Remedial Investigation and Feasibility Study (RI/FS) process at Cornhusker.

U.S. Army Corp of Engineers Waterways Experiment Station completed a site treatability study at CAAP in 1995.

The 25-gpm system has been designed and installed. The equipment will operate on-site for three to five months. Data collected will include influent and effluent concentrations, cost of equipment and resources, operational and maintenance costs, and any other pertinent information. A final report will include a cost analysis and all documented information. The researchers plan a follow-up effort to transfer the peroxone technology, using the data from this demonstration with developed implementation and design guidelines.

Limitations

This technology derives from advanced oxidative chemistry and involves the production of hydroxyl radicals that in turn react with and destroy most organic materials. The mass transport of ozone (gaseous at 2 percent to 5 percent) into the groundwater limits hydroxyl radical concentration to some degree. Because of this limitation, the technology may have difficulty treating refractory organic molecules at other than low concentrations (less than 1 ppm).

Applicability

This technology directly applies to the Cleanup pillar and addresses the following Army Requirements Statements:

- 1.2.a Explosives in Groundwater
- 1.2.b Organics in Groundwater
- 1.2.c Solvents in Groundwater

A number of Department of Defense (DoD) sites have groundwater that contains explosives and propellant materials and wastes. The explosives in groundwater affect drinking water supplies both on and off an installation, and DoD must provide potable water to affected communities. The Army user community has ranked "Explosives in Groundwater" as the fourth-highest requirement in environmental restoration research and development.

Accomplishments

WES has completed its field study at Cornhusker AAP and design of the full-scale system has begun. The project is on schedule for completion in February 1997.

Performance Needs

The demonstration should last three to five months on site. Data analysis, reporting and documentation will follow.

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Pink Water Treatment Technology Research Task

Purpose

To identify existing or develop innovative technologies to treat pink water. At least three technologies will be scaled up to the pilot level. The pilot tests (demonstrations) will provide enough information to help design and determine which technology is the most cost-effective for a full-scale system.

Background

The U.S. Army uses trinitrotoluene (TNT) as the main ingredient in high explosives, in several explosive mixtures loaded into warheads of various types. Handling TNT to prepare the mixtures, load, or rework the warheads involves water. This water contains TNT, minor amounts of production by-products, and degradation products. When exposed to light, these chemicals turn the water's color to pink. The main goal of any pink water treatment technology is not to remove the color but to remove or destroy the chemicals. (For clarity: Red water generated by TNT production may contain some chemicals found in pink water, but at much higher concentrations. Red water also has a high concentration of inorganic salts.)

The Army historically has used granular activated carbon (GAC) to treat pink water, an effective and low-cost method. However, because of new and anticipated additional regulatory requirements, the adequacy of this process has become questionable. Several methods of treating spent carbon now vary with requirements in states where the pink water is generated. Previously, open burning disposed of it at very low expense.

The discharge limits for pink water conceivably may be reduced significantly below the level at which GAC is effective. Any new treatment system must approach the life-cycle cost of the GAC treatment system to be considered a reasonable substitute.

Description

Researchers screened and evaluated pink water treatment technologies for their technical merit and cost-effectiveness. These five technologies are the best candidates for pink water destruction and will be tested on bench-scale:

- Large aquatic plants;
- GAC with thermophilic microbial regeneration;
- Fenton's Chemistry;
- Electrolytic oxidation; and
- Fluidized bed bioreactor.

Limitations

Limitations will be determined by the following criteria during bench-scale testing: health and safety, effluent quality, process operability, process flexibility, economics, and commercial availability.

Applicability

These technologies should be able to destroy TNT and other toxic (nitroaromatic) compounds in pink water and eliminate the need for treatment before discharge. These technologies also should be cost-competitive with traditional GAC treatment, followed by thermal regeneration or destruction.

ACCOMPLISHMENTS

The Phase I literature search is complete and a report has been submitted. Five technologies were selected for bench-scale testing.

PERFORMANCE NEEDS

Bench-scale testing with known waste streams from two Army ammunition plants (AAPs), to collect data for scale-up purposes and economic analysis; selection of three technologies for pilot-scale testing; and determination of technologies to demonstrate at two AAPs. Preparation of procurement and fabrication guidance for the recommended technology (out of three selected for pilot-scale testing).

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AVAILABLE DOCUMENTATION

Phase I Report, May 1995. Resource Utilization Plan.

Plant Management Information System for Noxious and Nuisance Plants

Purpose

The U.S. Army Corps of Engineers Waterways Experiment Station (WES) has developed a computer-based expert information system for noxious and nuisance plant management. The system allows installation managers to obtain information quickly about various management techniques for control of noxious and nuisance plants.

Background

This computer system resulted from a successful collaboration between WES and the U.S. Army Environmental Center's (USAEC) Environmental Technology Division. It initiated from military installations' need for alternate means to control and eliminate noxious and nuisance plant species that have infested installations.

Many species of noxious and nuisance terrestrial, aquatic, and wetland plants cause serious problems for military installations. When military activities disturb or destroy native vegetation, noxious and nuisance plants invade before native species have time to reestablish.

Description

The computer system is designed to use both text information and photographic-quality images for information transfer. The serial interface is highly graphical, using a "point-and-click" design for easy operation. The program has three main sections:

- The "Herbicide Recommendation" section allows researchers to decide on the use of various herbicides to manage noxious and nuisance plant species;
- The "Biocontrol Recommendation" section helps users understand clearly the use of biocontrol technology; and
- The "Nuisance and Noxious Plant Identification" section allows minimally trained personnel to identify and gain information on many noxious and nuisance plant species associated with military installations.

Limitations

The system includes 34 noxious and nuisance plant species. A much larger number of species are needed before the system can be used across all Army installations.

Applicability

The loss of native vegetation and soil structure on military installations allows noxious and nuisance plants to invade and inhibit native vegetation growth, directly altering the ecosystem. Restoring native species and eliminating noxious and nuisance species help stabilize the soil and gradually create a more natural environment. This environment is extremely important to military training areas because it allows installations to maintain realistic training areas to meet mission needs.

ACCOMPLISHMENTS

The system contains 34 species of noxious and nuisance plants with biological, mechanical, and chemical controls. A demonstration of the Plant Management Information System for Noxious and Nuisance Plants was held in Vicksburg, Miss., at WES, August 29-30, 1995. The demonstration allowed installation land managers to comment on the system.

PERFORMANCE NEEDS

Expansion of the number of plant species contained in the system is necessary for worldwide use on Army installations.

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Plasma Arc Technology Evaluation

Purpose

To evaluate the process capability of Plasma Arc Technology (PAT) for the ultimate destruction of hazardous item components; to verify slag suitability for regular landfill disposal; to identify potential hazards associated with the process emissions; and develop qualified cost estimates for use of the process with large-scale operations.

Background

Manufacturers of chemicals have used PAT for more than 30 years. NASA used it in the 1960s to simulate re-entry conditions during spacecraft development. The metallurgical industries later used PAT to prepare high-purity metals and to manufacture aluminum and steel.

The U.S. Army has a continuing need for better ways to dispose of environmentally hazardous military wastes. Substances of particular concern to the Army include organics, inorganics, heavy metals, and asbestos, which are toxic, carcinogenic, or both. The application of PAT to the destruction of hazardous waste is increasing worldwide. In 1991, the U.S. Army Construction Engineering Research Lab (USACERL) addressed the vitrification, or "glassification," of asbestos using PAT. USACERL collaborated in this effort with the Georgia Institute of Technology through the Army Corps of Engineers Construction Productivity Advancement Research (CPAR) program.

In 1992, the U.S. Army Armament Research, Development and Engineering Center (ARDEC) and USACERL investigated the feasibility of using plasma arc pyrolysis to destroy and permanently render inert armament-related hazardous wastes.

ARDEC helped to develop selection criteria and prioritized candidate hazardous wastes, while USACERL evaluated the feasibility of destroying these wastes with PAT. Feasibility tests were performed in August 1992 on four waste candidates: thermal batteries at Seneca Army Depot, Romulus, NY; metal contaminated soil at Picatinny Arsenal, Dover, NJ; and incineration ash and reject pyrotechnic smoke assemblies, both at Longhorn Army Ammunition Plant, Marshall, Texas.

Description

Concurrent Technologies Corporation (CTC), operating contractor at the National Defense Center for Environmental Excellence (NDCEE), is performing the plasma arc demonstration under contract to the U.S. Army Environmental Center (USAEC).

In Task 1, the contractor will identify problem wastes to be tested in Phases I and additional problem wastes for Phase II. Problem wastes in Phase I would include hazardous wastes remaining after treatment with conventional technologies, wastes still too corrosive to incinerators, metal-bearing wastes, and other such wastes. Phase II would test additional wastes, if wastes in Phase I don't require repeated tests in order to achieve optimal results.

Task 2 entails identifying a subcontractor who is able to treat the candidate waste materials in a suitable plasma waste system, based upon criteria specified in the Statement of Work. The PAT system should be able to destroy the selected waste materials.

Task 3 involves conducting and monitoring Phase I and Phase II testing, performed in accordance with a government-approved test plan and a quality assurance/quality control (QA/QC) plan. The slag should not be leachable, and the emissions shall comply with the federal Clean Air Act. Outreach materials will be prepared to promote PAT and will include a video, a descriptive brochure, a technical applications and analysis report to complement the brochure, and information entered into the Environmental Information Network (NDCEE) and the Defense Environmental Network and Information Exchange (DENIX). A cost estimate and procurement and design-fabrication guidance also shall be prepared.

Limitations

This technology costs more than many conventional technologies and should find its niche in the "hard-to-treat" wastes.

Applicability

PAT applies to the following types of wastes:

- Concentrated liquid organic hazardous wastes. These wastes, including polychlorinated biphenyls (PCBs), paint solvents, and cleaning agents, are the most expensive to destroy. Processes for chlorinated solvents and chlorofluorocarbons (CFCs) are in development. PAT is not affected by halogen concentrations.
- Low-level radioactive or mixed wastes. Plasma treatment offers the potential for the highest volume reduction and the formation of vitrified slags with the highest melting points. Its major advantage is requiring fewer steps to form the immobilized slag, because the same technology works for compaction and vitrification.
- Municipal solid wastes. These wastes, currently incinerated, contain combustible materials and could be hazardous because of metal content. PAT may be used to vitrify the ashes from the incinerator to eliminate hazardous materials.
- Medical wastes. Similar to municipal wastes, medical wastes have higher moisture content. PAT applies to these wastes if they contain metallic contaminants and if transfer to an incinerator is too expensive.
- Solid wastes contaminated with organic hazardous materials. These wastes include contaminated soils and containers filled with hazardous liquids (PCBs, chemicals, warfare agents). Plasma arc will destroy the organic toxins, vitrify the solid materials to an unleachable compact state, and remove contaminants such as HCl and volatilized metals.
- Concentrated wastes resulting from soil-washing operations.
- Wastes from manufacturing processes. This type of hazardous waste contains metal such as chromium, cadmium, and zinc as metallic dusts from metallurgical processes (e.g., electric arc furnace dust). This PAT application is attractive because recovery of a raw material makes the process more economical. For example, iron, zinc, and aluminum all can be recovered.

Accomplishments

Retech Inc. of Ukiah, Calif., was selected as the vendor to supply PAT equipment and perform the demonstration at its facility. Retech's equipment, Plasma Arc Centrifugal Treatment (PACT 1.5-foot diameter) was used in the USACERL/ARDEC work listed in the "Background" section, and a PACT 6 unit was used in Butte, Mont., to destroy hazardous wastes of interest to the U.S. Department of Energy (DOE) and pyrotechnic-related wastes for ARDEC. Retech was chosen because of its patent for centrifugal plasma arc design and because of its manufacturing prowess, should the system have problems during the demonstration and need new parts.

For this demonstration, Retech built a PACT 2 (2-foot diameter) that can process up to 100 pounds per hour, approximately four times faster than the PACT 1.5. It should help determine reasonable process costs for larger systems while still determining mass balances, an integral part of this demonstration. Although Retech could collect valuable information on validation destruction of various waste streams in the PACT 6 system at Butte, it could not determine mass balances because of a skull building up in the interior of the rotating hearth on top of the refractory.

The wastes selected for Phase I include:

- Picatinny Arsenal soil contaminated with energetics and heavy metals;
- Incinerator ash, spiked with components typical of hospital incinerator ashes, from the Medical Research Institute of Chemical Defense (MRICD), Aberdeen Proving Ground (APG), Md.;
- Media blast from Letterkenny Army Depot, Chambersburg, Pa.; and
- Sludge from Longhorn Army Ammunition Plant.

A Phase I demonstration was scheduled for completion by the end of August 1995.

Performance Needs

Hazardous waste candidates from various installations for which no acceptable waste disposal options exist because of cost factors, residual wastes after treatment with conventional technologies, incompatibility with waste treatment systems, or other legitimate reasons (i.e., permitting issues) that would preclude conventional treatment options.

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Follow-on Reactivity Study of Primary Explosives

Purpose

To assist the U.S. Army Environmental Center (USAEC) in conducting tests at various primary explosives concentrations and moisture levels, establishing a safety threshold reactivity level, and developing a data base at higher confidence levels.

Background

Since World War I, munitions have been manufactured in the United States using a variety of energetic materials, including propellants, explosives and pyrotechnic (PEP) materials. Many manufacturing sites contain explosives-contaminated soil as a result of prior and existing operations, including load, pack and repack, maintenance, storage, disposal, and demilitarization. Some of these sites contain primary explosives, such as lead azide and lead styphnate. Explosives-contaminated soils are considered hazardous materials under the federal Resource Conservation and Recovery Act (RCRA).

Description

The technical approach of the Follow-on Reactivity Study is as follows:

- Evaluate existing reactivity testing procedures used for primary explosives to determine applicability and develop alternative reactivity testing protocols, if appropriate.
- Develop a data base at higher confidence levels to verify the unqualified positive reaction that occurred at 7 percent (see "Accomplishments").
- Establish threshold initiation-level values for these primary explosives and establish safe-handling criteria.
- Investigate possible explosive segregation or concentration of wet samples (moisture levels).
- Develop optimal burn times and publish standard procedures.
- Plot probit graphs and calculate confidence levels.
- Evaluate primary reactivity levels in different soil types and fill data gaps.
- Evaluate effects of soil compactness and soils contaminated with larger agglomerates of primary explosives.
- Develop a procedure to prepare samples.

Diagram

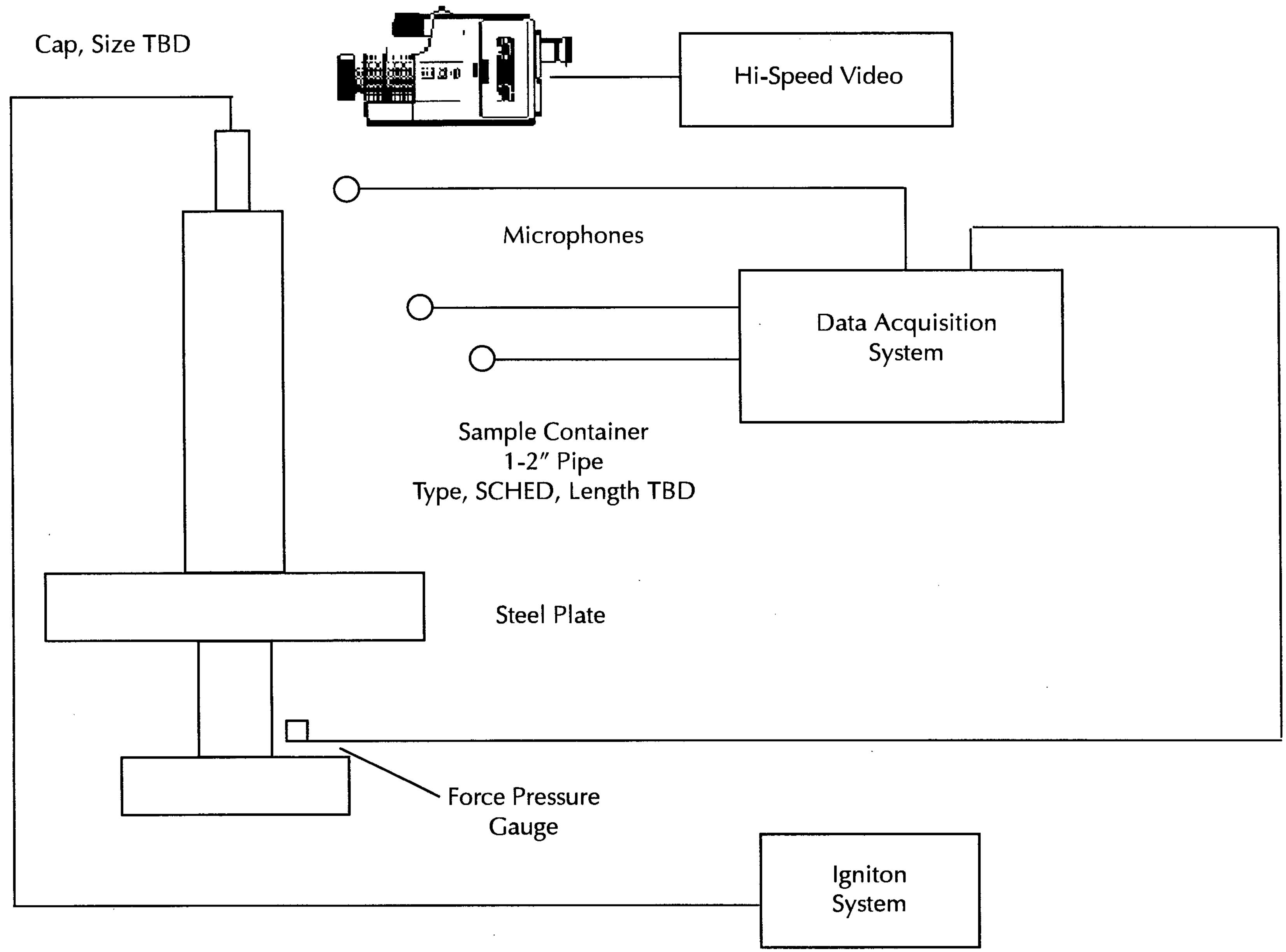
See Figure 11, Shock Test Concept.

Limitations

The U.S. Army's Remedial Investigation and Feasibility Study (RI/FS) activities at installations currently contaminated with primary explosives have been suspended until the specifics outlined under the following "Applicability" section are complete. The U.S. Department of Transportation must establish DOT hazardous-waste classifications for primary explosive wastes.

Figure 11

Shock Test Concept



Applicability

This study applies to *Andrulis Report* Requirement Statement numbers 1.5.g (Hazard/Risk Assessment of Military-Unique compounds). The study will help increase understanding of the overall safety threshold reactivity levels of primaries. This information will help determine safe concentration levels for personnel to investigate primary soil areas contaminated by explosives on Army installations.

The Army will use the results of this study to investigate installations currently undergoing RI/FS investigations (i.e., Picatinny Arsenal, N.J., Joliet Army Ammunition Plant, Ill., Sunflower AAP, Kan.). The Department of Transportation will use the results to establish DoT hazardous-waste classifications for primary explosive wastes. The Department of Defense Explosives Safety Board, and possibly private industries, will use the results in the manufacturing of primary explosives.

Accomplishments

Phase I reactivity study tests (#8 Cap, Bonfire, Zero Gap, and DDT), funded in 1994, were conducted with a 3-percent to 14-percent (by weight) mixture of primary explosives in soil. Lead azide was selected as the primary of greatest concern because it had the lowest reactivity levels of lead azide and lead styphnate. The lowest explosive concentration that recorded one unqualified positive reaction occurred with 7 percent lead azide in dry soil in the Bonfire test.

No other positive reaction occurred below 13 percent in soil for lead azide or lead styphnate. This study provided basic information and recommended a safety threshold reactivity level of 5 percent for lead azide and 10 percent for NG. Moisture levels appeared to affect reactivity. Mercury fulminate was not included in this study because few sites have mercury fulminate contamination. The issues listed in the technical approach must be addressed before these safety threshold reactivity levels can be adopted.

Follow-on Reactivity Study of Primary Explosives Evaluation of existing reactivity procedures has been completed and alternative reactivity testing protocols have been established. These test protocols will measure the force, over-pressure (sound) and/or pipe damage as criteria to differentiate a "GO" from a "NO GO" for safety threshold reactivity levels.

Performance Needs

Several Army sites are contaminated with primary explosives and, until an understanding of the overall safety threshold reactivity levels of primaries is identified, RI/FS investigations will be on hold at these sites.

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Recovery of Acetone and Sonochemical Destruction of Energetics from Oil Extraction

Purpose

To develop solvent extraction of explosives from soil as an alternative to incineration for treating explosives-contaminated soil.

Background

The manufacture of explosives; the load, assemble, and pack of explosives into munitions; and the demilitarization of munitions produced large quantities of wastewater discarded in lagoons. The soil around many production facilities has also been contaminated with explosives from past operations. Prior work with explosives-contaminated soil has shown that explosives can be removed effectively from soil with solvents, but the solvents must be recovered for reuse for the process to be economical. For safety reasons, conventional distillation columns cannot be used for this process.

Description

This project evaluates the use of a sonochemical reactor to destroy explosives in mixtures of solvents, water and explosives, then recover the solvent with vacuum flashing. This procedure will avoid concentrating the explosives at any point in the process as would occur in a distillation column. This laboratory research effort is under way at the University of Akron through the Army Research Office. Favorable laboratory results will fit into the design of a pilot-scale facility to treat explosives-contaminated soil at an Army facility.

Diagram

See Figure 12, Acetone Recovery and Sonochemical Destruction of Energetics.

Limitations

The major limiting factor will be the degree to which the sonochemical reactor can destroy individual explosives.

Applicability

This technology may apply to any site with explosives-contaminated soil.

Accomplishments

Since the project began in May 1995, it has focused on the design and fabrication of experimental equipment. It is scheduled to turn to establishing the degree of solubility of several explosives in different mixtures of solvent and water.

Performance Need

The major need of this effort is to develop laboratory data that prove the efficiency of the sonochemical reactor to destroy explosives in mixtures of the solvents, water and explosives.

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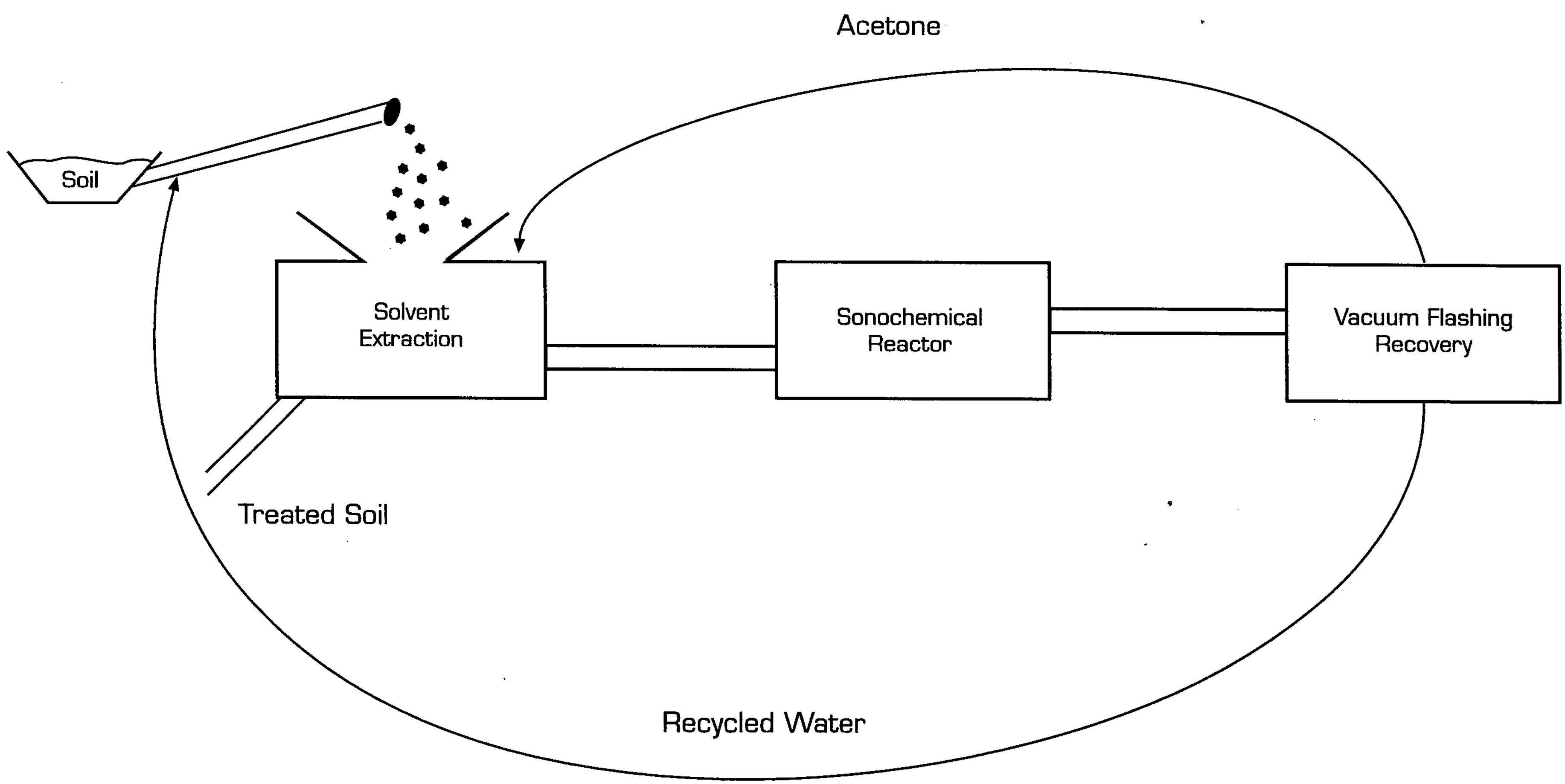
Figure 12

Acetone Recovery and Sonochemical Destruction of Energetics



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Remediation Technologies Screening Matrix and Reference Guide, 2nd Edition, October 1994

Purpose

This document offers information on widely used and presumptive remedies to limit remediation resources used in site characterization and evaluating a large number of remedial alternatives. When used in combination with other references, it should help researchers to efficiently identify a contaminated site and recommend suitable remediation technologies to environmental regulators.

The guide is designed help the reader identify possible treatment technologies, distinguish between emerging and mature technologies, and assign a relative probability of success based on available performance data, field use, and engineering judgment.

The guide allows the reader to gather essential descriptions of respective treatment technologies, and it incorporates cost and performance data. The guide focuses primarily on demonstrated technologies with available performance data; however, emerging technologies may be more appropriate in some cases, based upon site conditions and requirements.

Background

A distinctive attribute of environmental technology is the continually changing state-of-the-art. Federal agencies periodically update and publish information on remediation technologies, however, government remedial project managers (RPMs) often must sort through large volumes of related and overlapping information to evaluate alternative technologies.

To assist RPMs in this process and to enhance technology transfer among federal agencies, the Department of Defense Environmental Technology Transfer Committee (ETTC) and the Federal Remediation Technologies Roundtable (FRTR) developed this document. It combines the unique features of several agency publications into a single document, and allows RPMs to pursue questions based on contamination problems and specific technology issues depending on their need. The U.S. Army Environmental Center (USAEC) was the program and contract manager for the planning, development, and distribution of this document.

Description

Project staff members reviewed and compiled the unique features of several U.S. government reports into one digest document. It offers information on widely used and presumptive remedies to limit the remediation resources used in site characterization and evaluating every possible remedial alternative.

The U.S. Environmental Protection Agency (EPA) established presumptive remedies as the preferred technologies for common categories of sites, based on historical patterns of remedy selection and the EPA's scientific and engineering evaluation of performance data on implementing technology. Researchers also included commercially available, innovative technologies in this guide. Source information in the document originated from federal research facilities and from private-sector vendors involved in the research, development, and implementation of new and effective methods to characterize and clean up contaminated soil, groundwater, and structures.

The guide approaches site remediation from contaminant and treatment perspectives. The contaminant perspectives section presents a discussion of the properties and behavior of the contaminant groups, followed by a discussion of the most commonly used treatment technologies available for that contaminant group. The section identifies presumptive remedies available for the contaminant group. The guide separates contaminants into five groups: volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), fuels, inorganics (including radioactive elements), and explosives.

The guide divides each discussion of the contaminant groups into two media:

1) Soil, sediment, and sludge, and
2) Groundwater, surface water, and leachate.

(The VOC section also addresses air emissions and off-gases.) It presents matrices that summarize the treatment technologies applicable for each contaminant group. (Please note that these technologies are not necessarily effective at treating all contaminants in a group.) Information summarized includes scale status (full or pilot), applicability rating (widely or commonly used or limited use), and treatment function (destruction, extraction, or immobilization).

The treatment perspectives section provides a brief overview of 13 process groups and how they impact technology implementation (e.g., excavation considerations include additional cost, transport, permitting, and safety). The section assesses the following treatment areas:

- *In-situ* biological treatment for soil, sediment, and sludge.
- *In-situ* physical or chemical treatment for soil, sediment, and sludge.
- *In-situ* thermal treatment for soil, sediment, and sludge.
- *Ex-situ* biological treatment for soil, sediment, and sludge.
- *Ex-situ* physical or chemical treatment for soil, sediment, and sludge.
- *Ex-situ* thermal treatment for soil, sediment, and sludge.
- Other treatments for soil, sediment, and sludge.
- *In-situ* biological treatment for groundwater, surface water, and leachate.
- *In-situ* physical or chemical treatment for groundwater, surface water, and leachate.
- *Ex-situ* biological treatment for groundwater, surface water, and leachate.
- *Ex-situ* physical or chemical treatment for groundwater, surface water, and leachate.
- Other treatments for groundwater, surface water, and leachate.
- Air emissions or off-gas treatment.

Diagrams

See Figure 13, Role of the Remediation Technologies Screening Matrix and Reference Guide.

Limitations

The guide evaluates 55 treatment technologies, in four pages each. A master matrix helps to review and screen these technologies by evaluating and assigning ratings of "better," "average," or "worse" for each of these criteria: availability, residuals produced, part in a treatment train (yes/no), contaminants treated, system reliability and maintenance requirements, cleanup time, overall cost, and operation and maintenance or capital-intensive.

Innovative technologies to clean up hazardous waste sites have become increasingly popular, and new technologies continue to emerge. Member agencies of the Federal Remediation Technologies Roundtable plan to issue periodic updates of this document to help RPMs keep up with the ever-changing range of technology options available. Little information is available on cost and performance of cleanup technologies. Although the current edition included this information to the extent possible, it needs updating.

Applicability

U.S. government agencies and their contractors may reproduce the document, in whole or in part, for official business. All other reproduction is prohibited without prior approval of USAEC, SFIM-AEC-ETD, APG, MD 21010-5401.

Several thousand copies of the guide have been printed and distributed throughout the federal government, state governments, and private industry. A follow-up survey conducted during the summer of 1995 assessed its utility and effectiveness with recipients. Survey respondents indicated it was the best of its kind as both a screening tool and a reference guide.

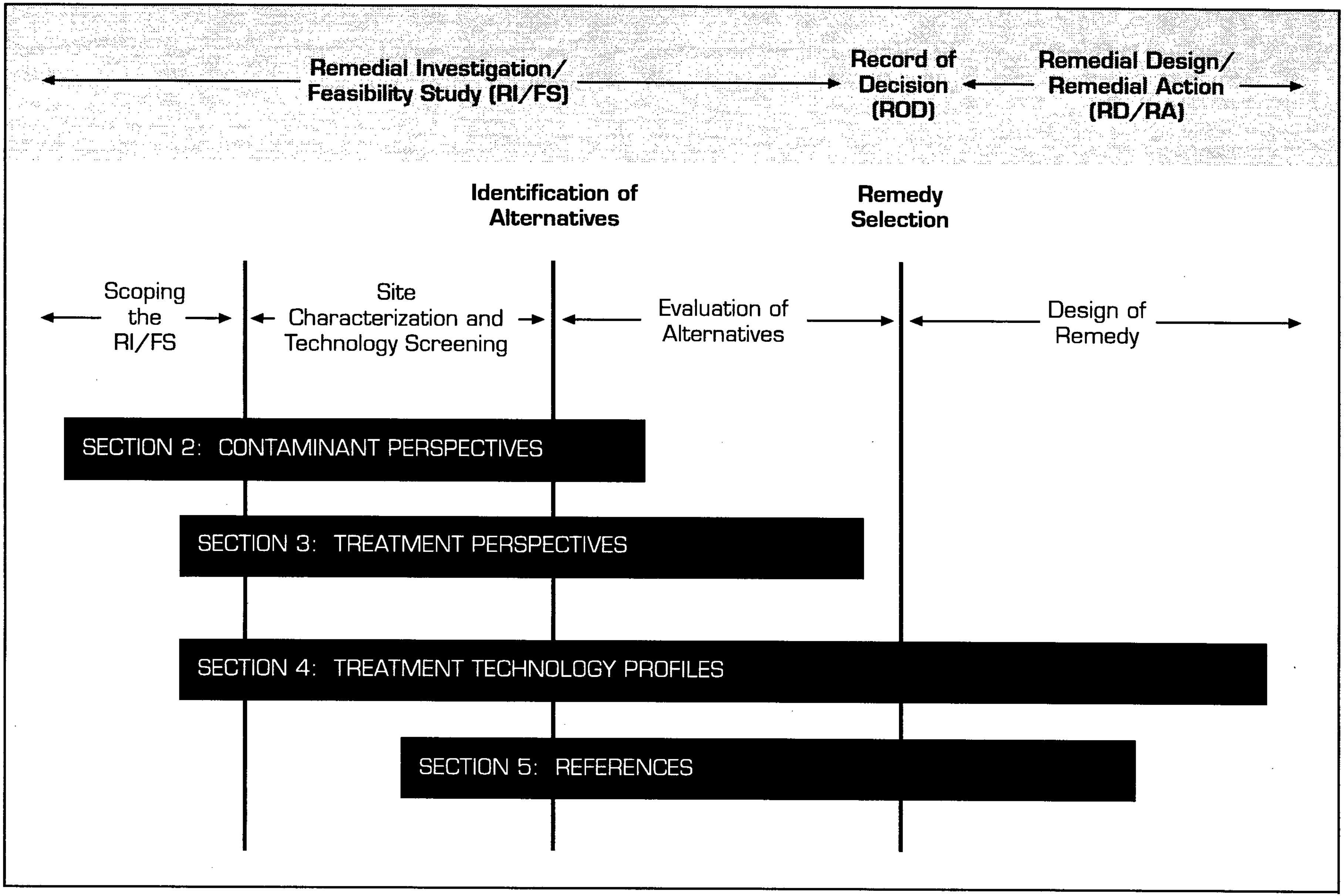
An enhanced electronic version of this guide with hyperlink features is available on CD-ROM for both WordPerfect 6.0 for DOS and WordPerfect Envoy for Windows. The DOS version requires users to have WordPerfect 6.0 loaded on their computers, but the Windows version does not. All software driving the Windows version is on the CD-ROM. Both versions are designed for local area networks (LANs), so several persons can read the information simultaneously from a single copy.

Performance Needs

The FRTR plans to update the guide. Although the members generally agree it should be primarily in electronic format, they also will require a condensed printed version. They expect the CD-ROM version to include optically-scanned images of the public-sector references listed in the document. They also expect to automate the screening matrix process to develop an electronic screening support tool. Researchers will investigate how to integrate future updated electronic copies into other electronic information systems containing similar information.

FIGURE 13

ROLE OF THE REMEDIATION TECHNOLOGIES SCREENING MATRIX AND REFERENCE GUIDE



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Individuals or groups willing to participate in future update efforts may contact USAEC at:

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AVAILABLE DOCUMENTATION

The National Technical Information Service (NTIS) publishes and distributes both the printed and electronic versions. NTIS, an agency of the U.S. Department of Commerce, is the central source for the public sale of technical and nontechnical information from government agencies. Most federal agencies have financial accounts with NTIS for ordering materials. If in doubt, contact your local publication officer or resource management division.

Call NTIS to request copies of Document No. PB95-104782 (paper copy) or No. PB95-501-771 (WordPerfect DOS and Envoy Windows versions). The NTIS telephone numbers are (800) 336-4700 (in the United States only) or (703) 487-4650 (international).

The electronic copy of the document can be downloaded from the EPA Alternative Treatment Technology Information Center (ATTIC). The ATTIC data base system is accessible through any personal computer or terminal equipped with communications software and a modem by dialing (703) 908-2138. A WordPerfect 5.1 version is available from the "Full Text Technical Document" menu option. The WordPerfect and Windows Envoy versions are available from the "Bulletin Board Access" menu option. Voice support at the ATTIC can be reached at (703) 908-2137.

Reuse of Waste Energetics as a Supplemental Fuel

Purpose

To develop a technology for reusing waste energetics as a fuel oil supplement in industrial boilers.

Background

The Army, as the sole Department of Defense (DoD) manager for explosives, is evaluating and developing safe, environmentally acceptable, alternative disposal and reuse technologies for its stockpile of waste energetic materials. These materials — propellants, explosives, and pyrotechnics — are commonly called PEP. Unserviceable materials remain from the manufacture of PEP, the assembly of munitions, and the demilitarization of obsolete conventional munitions. About 2.5 million pounds of scrap and off-specification energetic materials are generated each year, according to a 1985 estimate. Moreover, about 200,000 short tons of conventional munitions required demilitarization in 1990.

The disposal alternatives for these unserviceable PEP materials are open burning/open detonation (OB/OD) and incineration. OB/OD is the preferred method, but its use requires a Subpart X permit under the federal Resource Conservation and Recovery Act (RCRA). Because of environmental concerns, OB/OD is approved case-by-case. Incineration of energetic materials is uneconomical. To burn safely, energetic materials are mixed with about 75 percent water to form an energetic/material water slurry. The process requires water, which dramatically increases fuel costs, to prevent detonation propagation during the handling and feed process. Although OB/OD and incineration are acceptable disposal technologies, neither takes advantage of the energy content of these materials.

The U.S. Army Environmental Center (USAEC), formerly the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA), began investigating the feasibility of reusing energy from waste energetic materials to produce steam and electricity in 1984. Because explosives are a major waste energetic material in the Army's inventory, USAEC began investigating the potential of using TNT, RDX, and Composition B (60 percent RDX, 40 percent TNT) as a supplemental fuel.

Research has demonstrated successful disposal of waste-solvated explosives in the laboratory (1985), bench-scale studies (1988), and pilot-scale tests at Los Alamos (1989) and Hawthorne (1991). The boiler used in the pilot-scale test at Hawthorne, Nev., was a Cleaver-Brooks Model M4000, 2 million-BTU water-tube boiler, one-tenth the size of most boilers at Army facilities. The prototype explosives dissolving and blending system were proven out during the demonstration, and the technology demonstrated potential as an effective method to recover energy from waste explosives. Diluted solutions of TNT (1 percent) safely and effectively blended with fuel oil and cofired while achieving 99.99 percent destruction and removal efficiency (DRE). Roy F. Weston Inc. completed only five of the 18 planned test trials at Hawthorne, however, because its task contract expired and it encountered operational problems. The primary operational and safety problems resulted from the inability to keep TNT in the solution during testing at low temperatures. NO_X emissions increased significantly when cofiring even a 1 percent TNT/No. 2 fuel-oil solution.

Description

The technical objective of this project, funded by the Strategic Environmental Research and Development Program (SERDP), is to continue developing supplemental fuels technology. The pilot-scale equipment has moved to Indian Head Division, Naval Surface Warfare Center (IHDIV, NSWC), Indian Head, Md., where the Navy and the Army, as a result of a 1994 Memorandum of Agreement, will develop the technology together. Recommended modifications to the supplemental fuels system, as a result of the pilot-scale test at Hawthorne, are incorporated into the equipment design. Initial testing at IHDIV, NSWC shall use TNT-supplemented fuel (1 percent, 10 percent, 15 percent) and Camp B-supplemented fuel (1 percent, 4 percent, 8 percent) at various excess air percentages. Testing was scheduled to start in December 1995. Follow-up testing will investigate supplementing fuel with nitrocellulose (NC), nitroguanidine (NQ), AA2 double-based propellant, and Otto Fuel. The propellants shall be wet-ground and mixed with fuel oil and shall be fired through a slurry nozzle into the burner. Comparisons between solvation and wet-grinding will determine the preferred approach for firing the explosives-supplemented fuels.

Diagram

See Figure 14, Process Flow Diagram for Burning a Supplemental Fuel
See Figure 15, Process Flow Diagram for Burning a Supplemental Fuel

Limitations

The process requires mature slurry nozzles with recirculation capabilities to ensure that energetics do not plate out of energetic/fuel oil slurries in the supplemental fuel lines and create a detonation hazard. Another limitation is the identification of ideal solvents for their solubility and viscosity, economics, and health effects, should solvation prove to be the preferred approach for firing explosives-supplemented fuels.

Applicability

The process should apply to most waste energetics resulting from production, load and pack operations, and demilitarization of munitions.

Accomplishments

Roy F. Weston Inc., involved in the design of the pilot-scale boiler and pilot-scale testing at Hawthorne Army Ammunition Plant, was awarded a task order contract to assist IHDIV, NSWC in:

- Identifying data gaps from previous laboratory and bench-scale testing on explosives and propellants supplemental fuels testing, and recommending testing to optimize implementation of the technology;
- Identifying nitrous oxide abatement technologies that can be incorporated on a typical full-scale boiler system (at an Army installation) to ensure compliance with new Clean Air Act regulations;
- Identifying slurry nozzles suitable for firing wet-ground explosives and propellant/fuel oil slurries; and
- Providing operational and maintenance support during the pilot-scale demonstration on both explosives and propellants.

Weston has submitted final reports on NO_x abatement technologies, recommended slurry nozzles and submitted a draft report on data gaps and recommended testing. Weston also is arranging for a subcontractor to perform necessary solubility and viscosity studies to fill in the data gaps identified in the study. IHDIV, NSWC has been preparing the boiler and is having it certified for the demonstration, anticipated to start in November 1995.

Figure 14

Process Flow Diagram for Burning a Supplemental Fuel

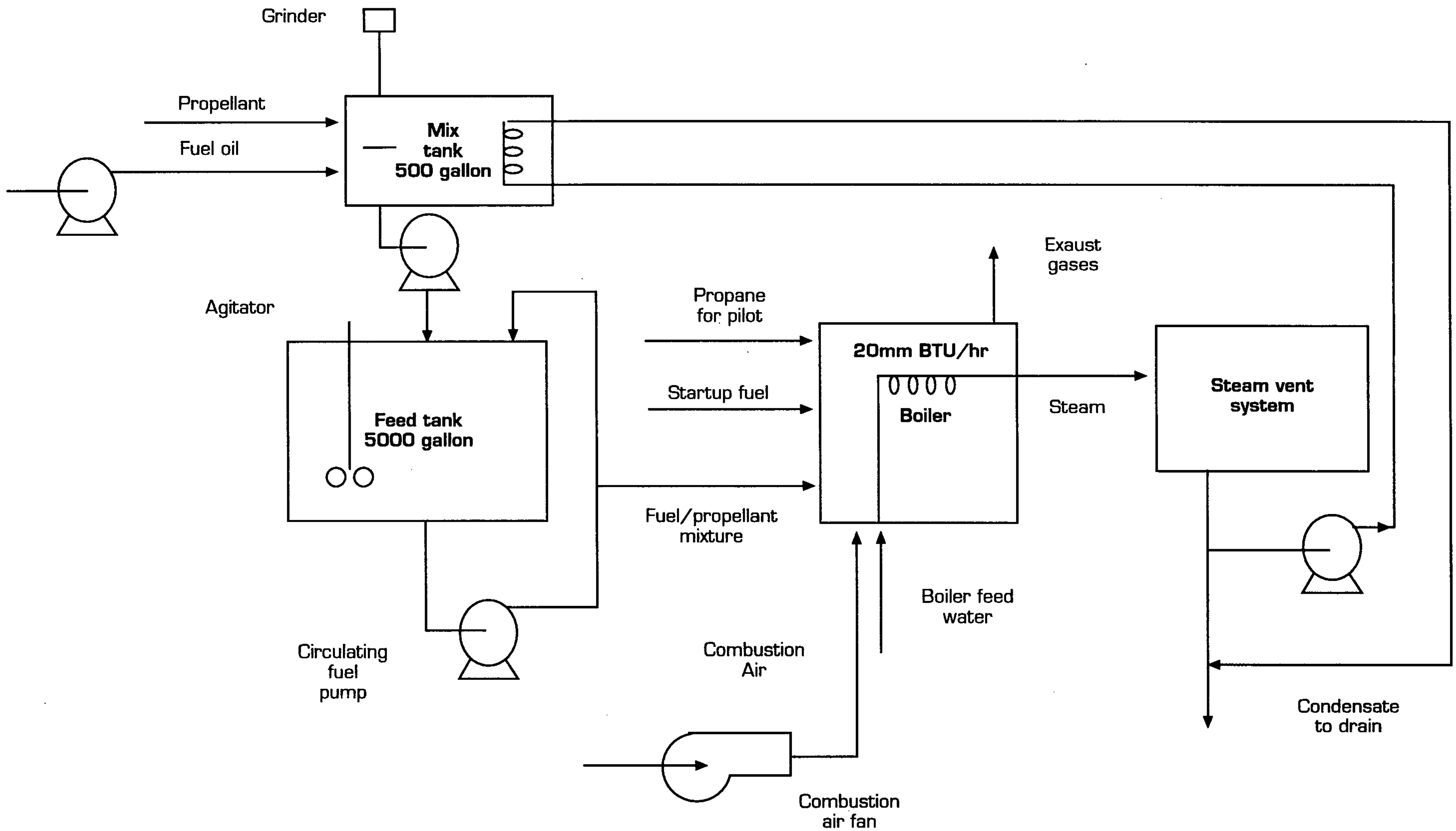
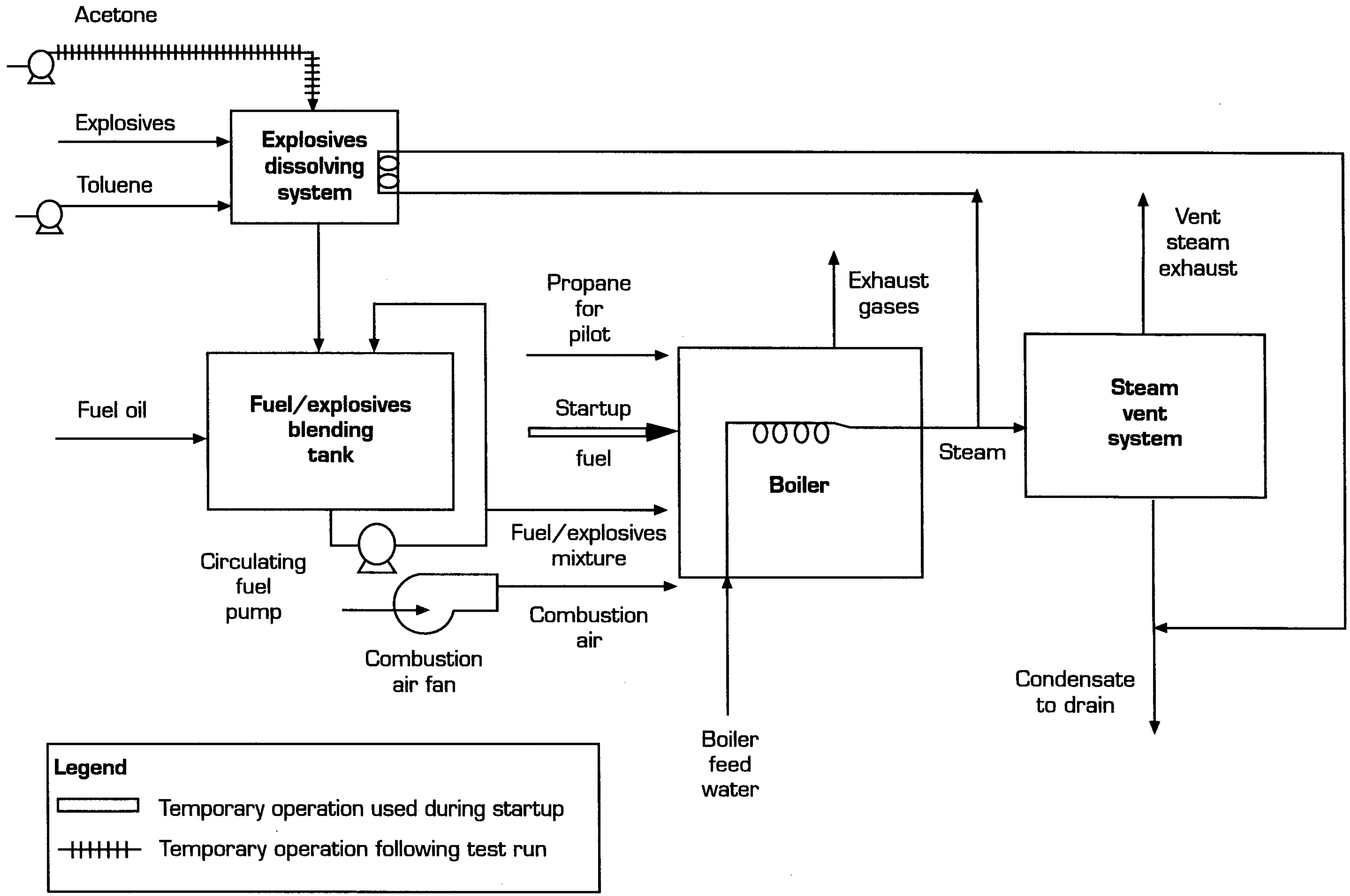


Figure 15

Process Flow Diagram for Burning a Supplemental Fuel



Performance Needs

Detailed accounts of munitions and missiles in demilitarization accounts to determine logistics and costs involved in extracting waste energetics for feed into supplemental fuels systems; determination of an installation possessing large amounts of waste energetics, a full-scale boiler for producing steam or electricity, and interested in conducting a full-scale demonstration (following the pilot-scale demonstration at Indian Head); and current estimates of waste energetics produced as a result of manufacturing and load-pack-assembly operations.

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Available Documentation

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Small-Arms Range Bullet Trap Feasibility Assessment and Implementation Plan

Purpose

To develop a guidance document for small-arms ranges to comply environmentally by using bullet trap systems that capture and permit recycling of heavy metals.

Background

Numerous Department of Defense (DoD) sites contain lead or other heavy metals from their use as small-arms testing ranges and practice ranges. Small-arms projectiles consist primarily of lead, listed in the federal Resource Conservation and Recovery Act (RCRA) as toxic material. If lead in soils and berms on small-arms ranges enters surface water or groundwater, it may violate RCRA and other laws. Future regulations may restrict testing and training activities and force valuable small-arms ranges to close unless the Army captures and recycles this projectile material and prevents contamination of range sites and the surrounding environment.

Conventional small-arms ranges contain heavy metals from projectiles fired in tests and training. Commercially available bullet traps can capture and contain the projectiles and may provide a means to recycle the projectile material and prevent contamination of the ranges and the environment.

Description

Techniques that limit the volume of soil containing heavy metals at small-arms ranges also will limit cleanup costs and prevent regulatory restrictions of test and training activities at active sites. Bullet traps at training sites that capture and contain the projectiles for recycling will limit or possibly prevent soil contamination.

Limitations

- Increased maintenance may be required for the bullet traps.
- The cost of installation and maintenance may be prohibitive.
- Deployment of bullet traps on ranges may limit training realism in some situations.
- Bullet traps may restrict range use to only the specific ballistic requirements of the traps.

Applicability

This technology applies to the Compliance and Conservation pillars. The Army Requirements Statements addressed include:

- 2.3.c, Develop Recycle and Reuse Technologies
- 2.3.d, Develop Alternative Technologies to Mitigate Contaminated Soil
- 4.3.a, Mitigating Army-Unique Impacts

Accomplishments

An evaluation of outdoor small-arms range designs and uses has been completed to develop criteria for bullet-trap implementation on the ranges. A technology identification search also has identified commercially available bullet traps.

Performance Needs

After project members complete the feasibility study and identify workable bullet traps, they may need to conduct pilot demonstrations and find suitable sites for these demonstrations.

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Solar Detoxification of Soil

Purpose

To develop a remediation system that uses solar energy to destroy organic contaminants desorbed from soil. The project is a collaboration among the U.S. Environmental Protection Agency Risk Reduction Engineering Laboratory (RREL), the Department of Energy National Renewable Laboratory (NREL), and the U.S. Army Environmental Center (USAEC).

Background

A soil-remediation system using solar energy may cost less and work more effectively than conventional technologies used by the Army to destroy organic contaminants. The process is doubly attractive for soil remediation because it can destroy contaminants without increasing the demands on traditional sources of energy.

Description

The system can use vacuum extraction to remove the contaminants from soils. The contaminants, can then be condensed and fed to a solar reactor. The contaminants will be destroyed by photochemical and thermal reactions.

Limitations

The system requires high levels of solar insolation.

Applicability

The system addresses to the Cleanup pillar and applies to semivolatile and volatile organic compounds and petroleum, oils and lubricants (POLs).

Accomplishments

The USAEC and NREL have completed preliminary cost and performance feasibility studies. The RREL has constructed a "mini-pilot" system for laboratory testing. Final design of a full-scale system has been completed.

Performance Needs

Performance data and cost assessment. Needs will be addressed during demonstration testing. Basic research and development must be performed by RREL if funding is available.

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Suitability of PVC, Stainless Steel and Teflon Well Casings for Use in Groundwater Monitoring

Purpose

To determine if the type of well-casing material affects the capability to monitor for trace levels of organic and inorganic pollutants in groundwater.

Background

Using stainless steel, polyvinyl chloride (PVC), and Teflon well casings in the construction of groundwater monitoring wells has raised concerns about whether the casing material might influence the capability to measure trace levels of pollutants in groundwater. Before this work, researchers had very little data about how to select material that would neither absorb the pollutant, thereby lowering the measured value, nor release a quantity of the pollutant, thereby giving an artificially high result.

Description

The results of this task will simplify the selection of well-casing material that does not interfere with the trace-level determination of pollutants in groundwater.

Accomplishments

A prior study indicated PVC was acceptable for groundwater wells containing trace levels of explosives. In the current study, researchers conducted sorption tests on PVC, Teflon, stainless steel 304, and stainless steel 316, using groundwater containing a series of chlorinated organics, nitro-organics, Cd, Pb, As, and Cr. Results to date indicate that Teflon absorbs significant levels of chlorinated organics. PVC also absorbed measurable amounts of chlorinated organics, but much more slowly than Teflon. Stainless steel tended to oxidize when exposed to groundwater.

Rusting resulted in the formation of a ferric hydroxide precipitate that absorbed organic species and released minor and major constituents of the pipe material. For this reason, the capability to replicate inorganic measurements was poor, resulting in high analytical variances. Researchers observed small losses of Pb from a solution for PVC during a 24-hour exposure. Overall, though, PVC might be the best compromise to determine both organic and inorganic pollutants in groundwater collected from a single well.

Researchers performed the previously-mentioned testing in the static mode by placing a sample of casing material in a container with contaminated water. To match real conditions better, they conducted tests in the dynamic mode, with contaminated water flowing over the sample of casing material. Results show similar behavior between the static and dynamic modes.

They also performed additional studies using the extremes of concentration on the casing material, from ppb levels to high solvent concentration. Testing on other materials with ppm levels showed that fiberglass-reinforced epoxy (FRE) reacts similar to PVC, while fiberglass-reinforced plastic (FRP) and acrylonitrile butadiene styrene (ABS) reacts much more. Researchers plan to evaluate acceptable materials with higher concentrations of volatiles (solvents) and their behavior toward metals. They also will demonstrate the effect of chemicals on sampler materials.

The U.S. Environmental Protection Agency (EPA) has incorporated these results into its most recent guidance (RCRA Groundwater Monitoring: Draft Technical Guidance; EPA/530-R-93-001, 1992).

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Supercritical Fluid (SCF) Technologies: Assessment of Applicability to Installation Restoration Processes

Purpose

To determine the costs and technical applicability of SCF technologies to treat U.S. Army Installation Restoration Program wastes and contamination. Before development, researchers performed a feasibility study.

Background

Army production, maintenance, and training operations generate a variety of hazardous materials. Customary disposal practices involved incineration or isolation in lagoons and landfills. Current regulatory constraints limit disposal options and require restoration of previous disposal sites. The Army seeks less-costly alternatives for disposal and restoration, as well as hazardous-waste controls for operations that still generate hazardous materials.

Recently-maturing SCF technologies may apply to this task. SCFs form by heating a substance above its critical temperature (the temperature where a fluid cannot reform regardless of the pressure exerted on a substance gas). SCFs are neither a gas nor a liquid, but homogeneous substances with some properties of each.

The U.S. Army Toxic and Hazardous Materials Agency (USATHAMA), forerunner of the U.S. Army Environmental Center (USAEC), evaluated SCF technologies more than 10 years ago for potential application in the Installation Restoration Program. The agency concluded then that SCFs possessed unique potential for applications where other technologies failed. However, SCF technologies at the time were not cost-competitive with more mature technologies. Because regulatory considerations changed and SCF technology matured, researchers now must reevaluate SCFs for disposal, restoration and hazardous waste controls. The original study served as a starting point.

Description

Project staff searched worldwide for literature on SCF technologies and development efforts. They contacted experts and visited sites during the data collection phase. They then evaluated the SCF technologies to determine the technical and economic applicability for removing explosives, chlorinated hydrocarbons and metals from soils and water and controlling hazardous waste streams from industrial operations at Army ammunition plants and depots.

Researchers evaluated such operations as explosives and propellant production, loading and packaging procedures, electroplating, degreasing and cleaning, and painting and stripping procedures. Staff also evaluated the potential of SCF technologies as alternatives for the open burning and open detonation of explosives, and they developed cost estimates and comparisons for all applications deemed technically feasible. However, they concluded SCF technologies still were not cost-competitive with existing technologies: Costs ranged from $700 to $4,900 per ton for the scenarios evaluated.

Project staff recommended the applications in which no other technology is available or where existing technologies are unacceptable to regulators and the public. They also developed cost parameters and factors to easily evaluate future technical developments and their impact on projected costs. A final report documents the effort and findings.

Limitations

Excessive costs; technical limitations include reactor corrosion and scaling.

Applicability

The technology applies to high content (greater than 10 percent) organic liquid waste streams, in which incineration is unacceptable as an alternative treatment.

Accomplishments

Final report published in March 1994.

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Available Documentation

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Transportable Hot Gas Decontamination

Purpose

To conduct a field demonstration of a transportable hot gas decontamination system capable of decontaminating explosives- or propellant-contaminated underground piping and sewer lines that have been excavated.

Background

This advanced technology effort builds upon a 1990 demonstration on larger equipment at Hawthorne Army Ammunition Plant (HWAAP), Nev., where the technology proved feasible for remediating explosives-contaminated sewer pipes and process equipment.

Description

Contractor Roy F. Weston Inc. shall identify commercially available components for a hot gas decontamination system, based upon costs, size, transportability, and ability to meet required operating characteristics for decontaminating pipes contaminated by explosives or propellants. While the contractor selects hot gas decontamination equipment, the contracting officer's representative shall consult with project officers in the U.S. Army Environmental Center's (USAEC) Restoration, Program Management and Oversight Division to select potential sites where piping contaminated by explosives or propellants has been buried or excavated, is no longer needed for current operations, and would be available for a field demonstration. As it selects sites, the contractor also shall initiate test planning, safety planning, hazard analysis, and environmental permitting. The firm then shall prepare the sites, assemble the transportable hot gas decontamination equipment, and perform a validation test to ensure that the system operates within specifications. The contractor shall make any necessary modifications and perform additional validation tests until the system meets specifications, before it starts the field demonstration.

Limitations

Some piping, process equipment or contaminated debris with gross energetic contamination (i.e., visible chunks) may not have undergone washdown procedures because of potential detonation hazards. Components must be able to fit into the transportable hot gas decontamination furnace (5 feet wide, 5 feet high, and 12 feet long).

Applicability

This technology applies to any piping or process equipment of suitable size with internal surfaces or parts that are hard to decontaminate with physical methods or with contaminated surfaces that retain contamination even after a surface decontamination.

Accomplishments

The contractor identified furnace and afterburner manufacturers and asked them to design and detail transportable hot gas decontamination components to system specifications. Weston also shop-tested components and shipped them to Alabama Army Ammunition Plant (ALAAP), the site on the base closure list selected for the field demonstration. The firm developed a safety plan, a test plan, and site-specific engineering. It cleared and grubbed the site and negotiated with the Alabama Department of Environmental Management for final approval of the Treatability Study Test Plan scheduled for August 1995. The field demonstration was scheduled to begin in Fall 1995.

PERFORMANCE NEEDS

Identification of sites where installation restoration or base closure activities have left an abundance of energetics-contaminated piping or sewer lines, process equipment, or other energetics-contaminated debris of suitable size, and installations also interested in potential transfer of the transportable hot gas decontamination for treatability studies and cleanup activities.

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Treatment of Propellant Production Wastewater Containing 2,4 Dinitrotoluene

Purpose

To consider, demonstrate, and evaluate the two most promising technologies that will help Radford Army Ammunition Plant (RAAP), Va., comply with National Pollutant Discharge Elimination System (NPDES) requirements for 2,4 dinitrotoluene (DNT) in its wastewater effluent.

Background

DNT, used in the production of propellants at RAAP is considered waste under the Resource Conservation and Recovery Act (RCRA) and is a suspected carcinogen. It also has been linked to heart disease by some studies. The existing biological wastewater treatment plant (BWTP) at RAAP receives wastewater containing DNT from several propellant production operations before discharge into the New River under a NPDES permit. Previous studies indicated that the BWTP receives influent containing up to 75 mg/L of DNT. The current daily discharge limits for DNT are 113 μg/L (average) and 285 μg/L (peak). The 113 μg/L level is based on the measuring limitations of the analytical methods available when current regulations were proposed. Improvements in the analytical methods have since lowered detection levels to the range of several parts per billion. The chronic toxicity reference level for 2,4 DNT is 0.5 μg/L and could become more stringent in the future; discharge requirements as low as 25 μg/L, for example, have been implemented in Australia.

Although the BWTP is able to satisfy current NPDES discharge requirements for DNT most of the time, the plant has made several excursions above the 285 μg/L level.

Description

To help RAAP comply with the more stringent NPDES permit requirements, the U.S. Army Environmental Center (USAEC) sponsored an engineering study from 1989 to 1991 to identify the plant's production sources of DNT and characterize the flows and concentrations of the wastewater streams emanating from these sources. The study included limited bench-scale testing of treatment technologies. About 75 percent of the DNT-bearing wastewater originated from the water-dry process. In this process, excess DNT leaches from the propellant along with high concentrations of ethanol and ether. The wet screening and solvent recovery operations contribute about 18 percent and 7 percent of the DNT load to the BWTP, respectively.

This preliminary study concluded that interception and pretreatment of DNT-bearing wastewater upstream of the BWTP could reduce significantly the DNT load to the BWTP at concentrations above the proposed regulatory limit. Design flow rates and concentrations were established at 125 gpm at 75 mg/L of DNT, 500 mg/L of ethanol, and 10 mg/L of ether. The study concluded that both granular-activated carbon (GAC) and ultraviolet oxidation (UV/OX) technologies effectively treated 2,4 DNT. It also concluded that biodegradation of 2,4 DNT is another technology warranting further studies.

The U.S. Army Construction Engineering Research Laboratory (USACERL) subsequently investigated the feasibility of using an anaerobic fluidized bed bioreactor (AnFBR) with GAC to treat 2,4 DNT-containing wastewater. In a bench-scale study, performed with both simulated DNT wastewater and actual wastewater generated by the water-dry process at RAAP, the AnFBR system offered favorable prospects. The by-product of anaerobic degradation of DAT to 2,4 Diaminotoluene (2,4 DAT), aerobically degraded very easily.

USAEC started its current pilot-scale demonstration project in 1993 to select and evaluate the two most promising technologies for pretreatment of DNT wastewater. From an initial literature search and evaluation of the USACERL study, researchers concluded the best technologies suitable for a pilot demonstration included the AnFBR and UV/OX systems. They leased the UV/OX system, purchased the AnFBR system and began pilot-testing both during the summer of 1994. They also selected a small-scale rotating biological contactor (RBC) unit already at RAAP for use in a treatment train with the AnFBR system. This treatment train is designed to simulate pretreatment in a full-scale AnFBR system, followed by discharge to the BWTP. Researchers completed pilot-tests for both systems in the summer of 1995, and final analysis continues. The final demonstration report is expected to support the selection and design of a full-scale pretreatment system at RAAP. Researchers also hope the lessons learned from the pilot demonstrations will benefit other users of these technologies.

UV/OX uses ultraviolet radiation in combination with oxidants such as ozone (O_3) or hydrogen peroxide (H_2O_2) to produce hydroxyl radicals. Hydroxyl radicals are second only to fluorine in their oxidation potential and have effectively treated industrial wastewater containing semivolatile compounds. The UV promotes the formation of hydroxyl radicals in the presence of hydrogen peroxide.

In the AnFBR system, a vertical tank containing GAC, untreated wastewater and a recycle stream from the reactor feed back into the reactor from the bottom with sufficient velocity to fluidize and expand the bed volume of GAC by a factor of about 1.5. The GAC functions to provide a substrate to support microbial growth, and capture, through adsorption, surge loads of DNT. During periods of low flow or low DNT concentration, the DNT adsorbed on the carbon bed desorbs, and the bacteria degrades it and regenerates the carbon bed. The contact time required for effective treatment, one of the variables evaluated during the demonstration, depends on the DNT concentration and on the presence of other competing metabolites. A portion of the column effluent is recycled to maintain the bed as a fluid and to permit the wasting of sludge-carbon as necessary. Methane gas generated by the anaerobic biological activity in the reactor is discharged to the atmosphere from a vent in the top of the reactor.

Diagram

See Figure 16, Process Flow Diagram - UV/Oxidation Pilot-Test System.
See Figure 17, Process Flow Diagram-Exivirex System.

Figure 16

Process Flow Diagram - UV/Oxidation Pilot-Test System

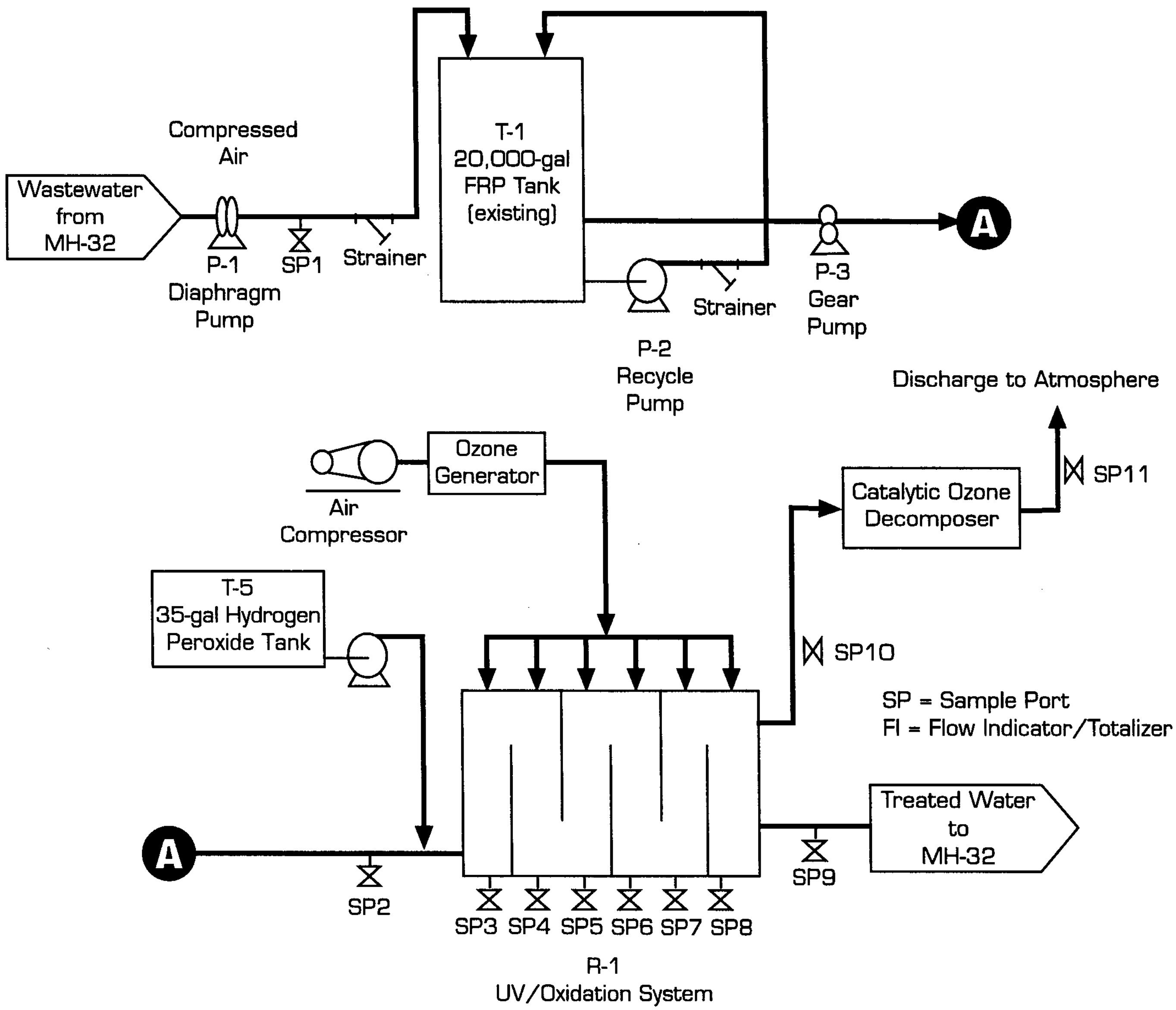
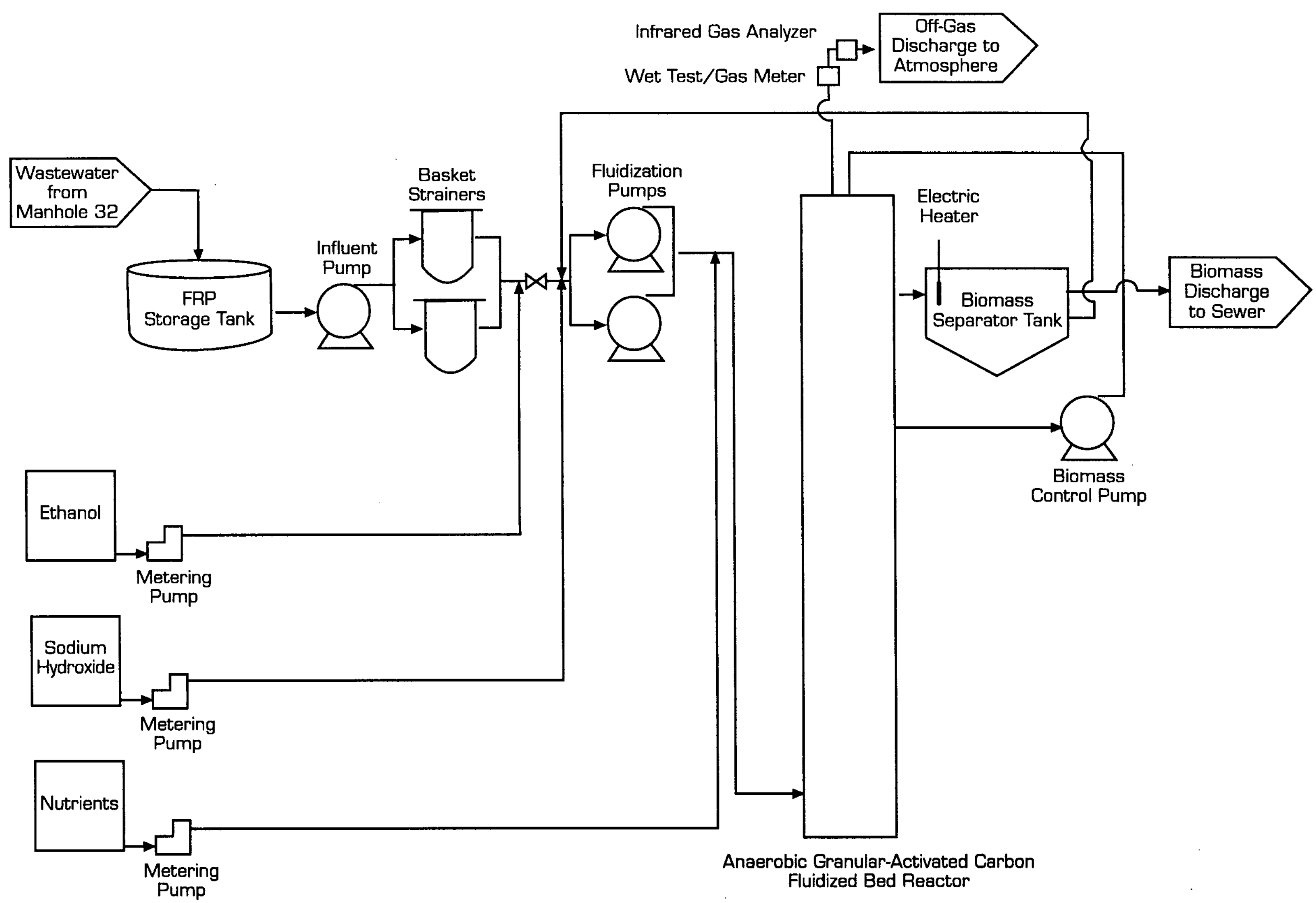


Figure 17

Process Flow Diagram-Envirex System



Limitations

The UV/OX system's performance depends on the concentrations of ethanol and ether in the wastewater because of the competition for available hydroxyl radicals. During the pilot tests, this system failed to reduce DNT concentrations to the detection limit, except at very high oxidant dosages and extended residence times. The target effluent load (113 μg/L) was difficult to achieve in the presence of ethanol and ether. However, the system consistently removed more than 65 percent of the DNT in the wastewater.

The BWTP requires an evaluation to determine if this removal rate would permit the bioplant to meet anticipated discharge requirements. Researchers also must continue evaluating the chemical analyses to reach conclusions on the full-scale performance and costs of operating this system.

The tests performed on the AnFBR system indicate it can achieve the target effluent quality. However, staff performed these test runs at flow rates of 0.4, 0.8, and 1.2 gpm (i.e., retention times of 12, 6, and 4 hours). Again, researchers must continue evaluating the chemical analyses to reach conclusions on the full-scale performance and cost of operating this system. The AnFBR system also produced 2,4 DAT in the effluent. Although 2,4 DAT biodegrades aerobically, there are no current regulatory standards for its discharge requirements.

Applicability

The objective of this demonstration is to help RAAP comply with NPDES discharge requirements on DNT. The Army technology user requirement for this problem fits under the Compliance pillar as "Alternative Treatment Methods for Redwater/Pinkwater." Although the load, assemble, and pack operations of munitions, and not propellant manufacturing as at RAAP, generate pink water, researchers believe the main constituent of 2,4,6 trinitrotoluene (TNT) applies to the AnFBR system. In fact, bench-scale testing conducted by USACERL shows the AnFBR system will work for TNT.

Accomplishments

Both demonstrated technologies destroyed DNT in wastewater to acceptable levels. A final report, to be completed with full analysis by December 1995, will help the selection and design of a full-scale pretreatment technology.

Performance Needs

Further analysis will determine the advantages and disadvantages of each technology. The research also must determine how much pretreatment is required to allow the BWTP to handle the remaining concentration of DNT it receives.

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Available Documentation

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Tri-Service Site Characterization and Analysis Penetrometer System (SCAPS)

Purpose

To develop a rapid means of characterizing subsurface contamination and to reduce site characterization costs by reducing the number of monitoring wells and soil borings at a site.

Background

Past manufacturing, handling, and disposal of hazardous materials at Department of Defense (DoD) facilities has resulted in the contamination of soil and water. Current methods for characterizing contaminated sites are costly and time-consuming. Traditional site characterization includes drilling, sampling, and shipping the samples to a laboratory for analysis. Researchers repeat these steps as necessary to fill in data gaps. The process can take weeks, months or years to complete.

The U.S. Army Environmental Center (USAEC) leads a tri-service effort to enhance existing cone penetrometry with chemical sensors to detect and delineate site contamination. Current capabilities include petroleum, oil and lubricant (POL) screening, identification of stratigraphy, soil resistivity measurements, and micro-well installation. These capabilities have successfully been evaluated by the EPA Superfund Innovative Technologies Evaluation (SITE) program and are in the process of validation in the EPA Consortium for Site Characterization Technologies (CSCT).

Description

The core technology, known as the Site Characterization and Analysis Penetrometer System (SCAPS), consists of a uniquely engineered 20-ton truck and includes a suite of surface geophysical equipment, survey and mapping equipment, special penetrometers with contamination detection sensors, and soil or groundwater samplers.

The SCAPS unit can identify soil types and layering (with a 2 cm resolution), subsurface anomalies, and petroleum product contamination to depths of 150 feet. The penetrometers are driven into the soil from the vehicle at a rate of about 1 meter per minute, with its sensors measuring the physical and chemical characteristics of the soil and other materials. The information generated during the push is transmitted to the vehicle's data processing area, allowing for near real-time results on site. The data are typically processed off-site — though on-site processing can be done — resulting in a three-dimensional image of soil conditions. These "maps" depict soil layering and location of contaminants detected by the penetrometer's sensors.

Diagram

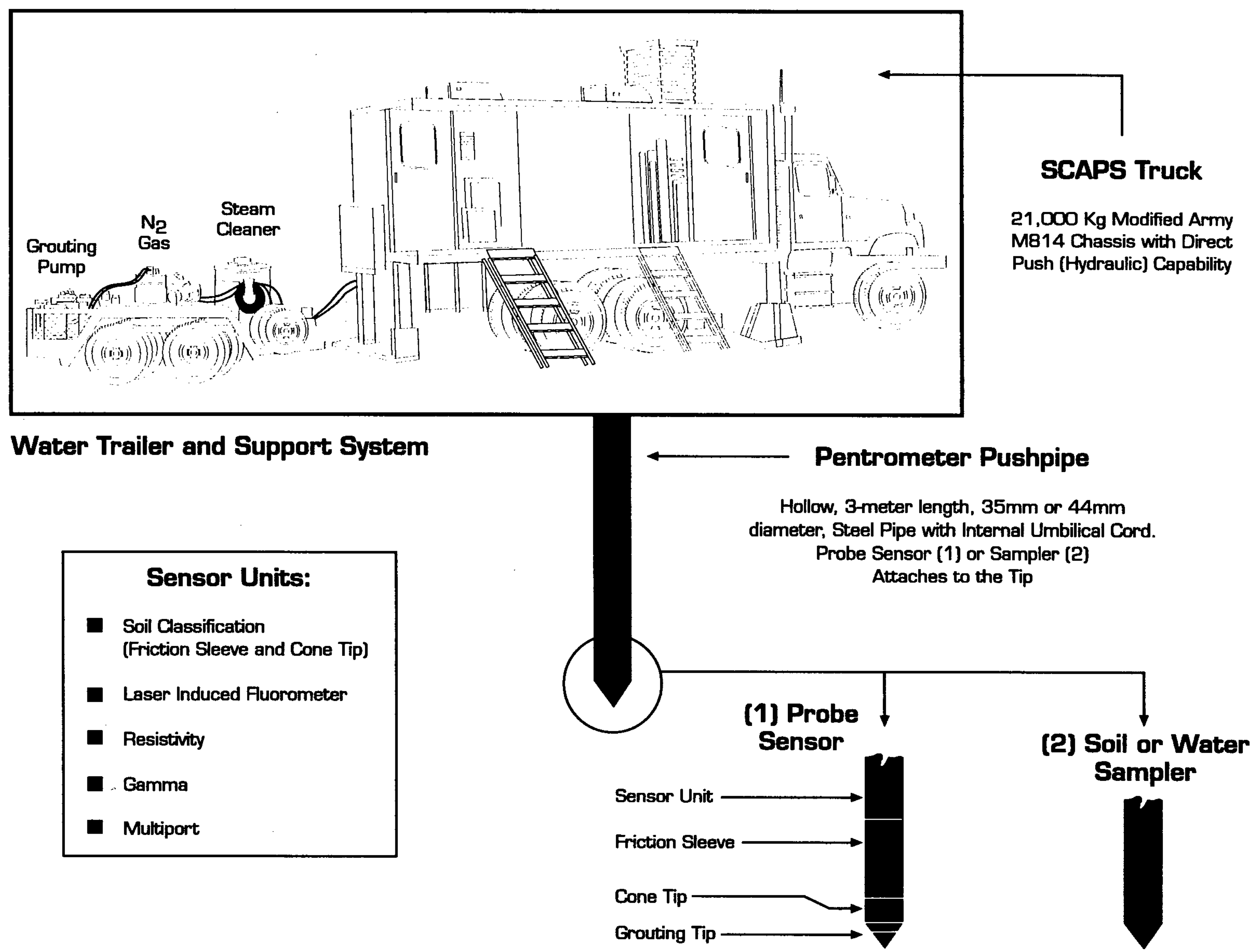
See Figure 18, Site Characterization and Analysis Penetrometer System.

Limitations

SCAPS works best with clayey to sandy soils; it cannot penetrate bedrock or well-compacted soils, and cobble may limit the extent of the push. High-relief areas may require site preparation to facilitate leveling the vehicle.

FIGURE 18

SITE CHARACTERIZATION AND ANALYSIS PENETROMETER SYSTEM



Applicability

The system applies to the following Army Requirements Statements:

- A.1.1, Develop Improved Field Analytical Techniques (1.1.a)
- A.1.11, Alternative Techniques for Sub-Surface Characterization (1.1.k)
- A.3.46, Rapid Field Sample Analysis (3.7.f)

SCAPS applies to all DoD installations, Formerly Used Defense Sites (FUDS), Department of Energy (DoE), Department of Interior (DoI), and EPA-EMSL sites.

DoD users have identified four types of chemical contaminants for which they would like to have SCAPS sensors developed (explosives, chlorinated solvents, non-chlorinated solvents, and metals).

Accomplishments

- The POL sensor has completed field demonstrations successfully at many DoD and DoE sites.
- The POL sensor has completed field demonstrations successfully at many DoD and DoE sites.
- The POL sensor technology has been patented and licensed for commercial production and marketing.
- Researchers successfully solicited funding to accelerate SCAPS sensor development.
- Researchers completed the fabrication and initial field evaluations of an explosives-sensing probe.
- Researchers conducted a field evaluation of all prototype solvent-sensing and -sampling devices that could be deployed with the SCAPS.
- Researchers conducted a field test of the in-situ sparger/Hydropunch/ITMS for the delineation of solvent-contaminated sites.
- Formalized coordination of SCAPS sensor development efforts among DoD, DoE and the EPA.
- The Army has transitioned three SCAPS trucks to the Corps of Engineers to characterize Army and Air Force sites. The Navy is operating two trucks to characterize Navy site.
- The state of California has certified the laser-induced fluorescence (LIF) technology. Reciprocity with other states is being pursued.

Performance Needs

The program will need additional funding for the sensors currently being developed, to conduct demonstrations, and to pursue regulatory acceptance.

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Ultrasonic Cleaning with Aqueous Based Detergents

Purpose

To help the U.S. Army reduce its reliance on chlorinated solvents that are either banned under the Montreal Protocol or regulated as carcinogenic compounds.

Background

Methyl chloroform (1,1,1-trichloroethane or TCA) and trichlorotrifluoroethane (CDFC-113) are considered ozone-depleting substances and banned under the Montreal Protocol. Their production is restricted after 2005 and 2000, respectively. Efforts were under way to accelerate the phase out to Dec. 31, 1995. Traditional paint-stripping chemicals methylene chloride and perchloroethylene (perc) are suspected carcinogens. Permissible exposure levels are being lowered on these compounds.

Description

The U.S. Army Environmental Center (USAEC) surveyed Army depots to assess their operations and determine applicable alternatives for lowering their reliance on these chlorinated solvents. This initial survey resulted in a decision to research alternatives to conventional degreasing agents. A feasibility study was conducted on aqueous detergents in ultrasonic cleaning tanks at the Oak Ridge Field Office of the Department of Energy. A large-scale (400-gallon) ultrasonic cleaning tank was purchased and a field study was completed Corpus Christi Army Depot (CCAD), Texas, in the fall of 1994. Comparative testing and analysis of four aqueous detergents were made at various operating temperatures for several contaminated metal parts. The study proved conclusively that aqueous cleaning is a suitable replacement for degreasing contaminated parts before plating in the plating shop at CCAD. Aqueous cleaning will replace 1,1,1-trichloroethane in the depot's standard operating procedures. CCAD also might replace 1,1,1-trichloroethane with aqueous cleaning in its non-destructive testing laboratory.

Diagram

See Figure 19, Ultrasonic Cleaning with Aqueous Based Detergents.

Limitations

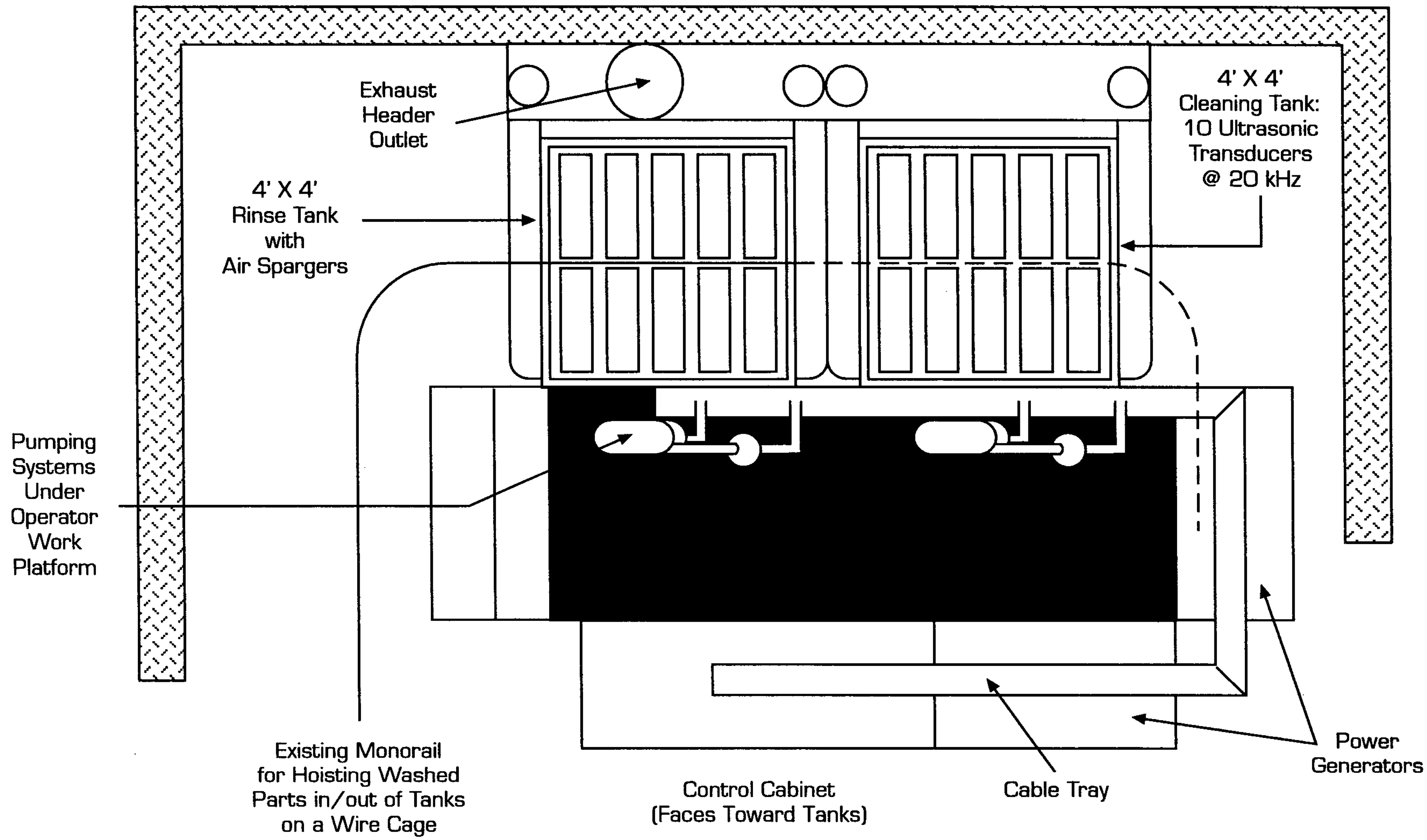
Aqueous cleaning may take longer than conventional degreasing methods. For example, time required for the ultrasonic tanks to reach operating or cooling temperature before discharge into the wastewater treatment system may be extensive, depending on the time of year and size of the tank and heater elements. The optimal temperature, detergent, and detergent concentrations must be determined for specific applications. Special filtering systems may be required to extend the life of the detergent.

Applicability

The CCAD study proved that aqueous cleaning can replace current methods for degreasing contaminated parts before plating in the plating shop. Aqueous cleaning will replace 1,1,1-trichloroethane in CCAD's standard operating procedures. CCAD is considering aqueous cleaning to replace 1,1,1-trichloroethane in its non-destructive testing laboratory.

Figure 19

Ultrasonic Cleaning With Aqueous Based Detergents



NOTE: Both tanks are stainless steel and contain heater coils with recirculation and filter systems.

ACCOMPLISHMENTS

The ultrasonic cleaning system demonstrated in this project remains operating at CCAD. Army installations with similar operations will benefit from the lessons learned.

PERFORMANCE NEEDS

Specific studies are required for each application to optimize the system. Results of this study, however, have demonstrated the capability of aqueous based detergents, when coupled with ultrasonic cleaners, to reduce or eliminate the need for conventional chlorinated degreasers within the Army.

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AVAILABLE DOCUMENTATION

USAEC final report, *Demonstration Testing of an Ultrasonic Cleaning System at Corpus Christi Army Depot,* February 1995, Report Number SFIM-AEC-ETP-CR-95027.

Unexploded Ordnance Clearance Technology Program

Purpose

To oversee a comprehensive program to demonstrate and evaluate clearance technology for unexploded ordnance (UXO) that includes detection, identification, remediation, and information management technologies. The need for UXO technology is well-documented in the U.S. Army Environmental Research and Development Requirements (*Andrulis Report*, January 24, 1994) and the Tri-Service Environmental Research, Development, Test, and Evaluation Strategic Plan (January 1994).

Background

Many U.S. government sites contain UXO as a result of military testing and training activities conducted over the past century. The variety and quantity of unexploded munitions at these sites, and the associated risks to human health and the environment, have created a need for advanced technology to locate and safely remove buried UXO.

The U.S. Army Environmental Center (USAEC) oversees a comprehensive program to demonstrate and evaluate clearance technology for unexploded ordnance that includes detection, identification, remediation, and information-management technologies. Projects in progress under the UXO Clearance Technology Program include:

1) UXO Advanced Technology Demonstration (ATD) and Evaluation Program.

   In response to a congressional mandate, USAEC established the ATD program to identify and evaluate innovative and cost-effective technologies for UXO detection, identification, and remediation; establish a performance baseline; and measure the state-of-the-art of UXO clearance technology. Researchers have conducted controlled site and live site demonstrations under the scope of this program during FY94-FY96.

2) Sensor Enhancements.

   Systems using sensors to locate and identify subsurface UXO and enhanced within this program include:

   - Subsurface Ordnance Characterization System, which is a multisensor data acquisition system to be used as a test bed to evaluate emerging sensor technology for UXO;
   - Airborne Ground Penetrating Radar (GPR), used to define boundaries of UXO contamination and the concentration or extent of the contamination;
   - Pulsed Electromagnetic Induction, to adapt and perfect methodology and perfect associated techniques for detecting and characterizing UXO;
   - Manually Portable Ordnance Detection System, an automated, portable area survey system that uses magnetic anomaly detection, navigational systems, and central data collection and target discrimination techniques to locate UXO; and

- Advanced Real-Time Imaging for Synthetic Aperture Radar, which uses an existing hand-held GPR system to determine the best image-processing routines for detecting, identifying, and localizing UXO.

3) Advanced Data Analysis Improvements, enhancing systems for analyzing raw data generated during UXO surveys under this program, including:

   - Ordnance Detection Expert Support Application,
   - Target Classification Using Magnetometers,
   - Data Analysis Algorithms for Detecting and Identifying UXO with Magnetometers,
   - Clutter Suppression for GPR, and
   - Remote Sensing of Surface UXO with an Active Laser and Passive Infrared Airborne Line Scanner.

4) Robotic UXO Remediation: Enhancing robotic remediation to remotely remediate UXO and to ensure the safety of system operators.

5) UXO Information Management Systems: Developing site management models and an information repository to manage and perfect the use of current UXO data.

6) Technology Transfer (T2) Program: The T2 outreach program disseminates information on the UXO Clearance Technology Program and provides an interactive forum for exchanging information on UXO technologies.

DIAGRAM

See Figure 20, UXO Clearance Technology Program Key Project Interrelationships.
See Figure 21, Advanced Technology Demonstrations.

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Figure 20

UXO Clearance Technology Program Key Project Interrelationships

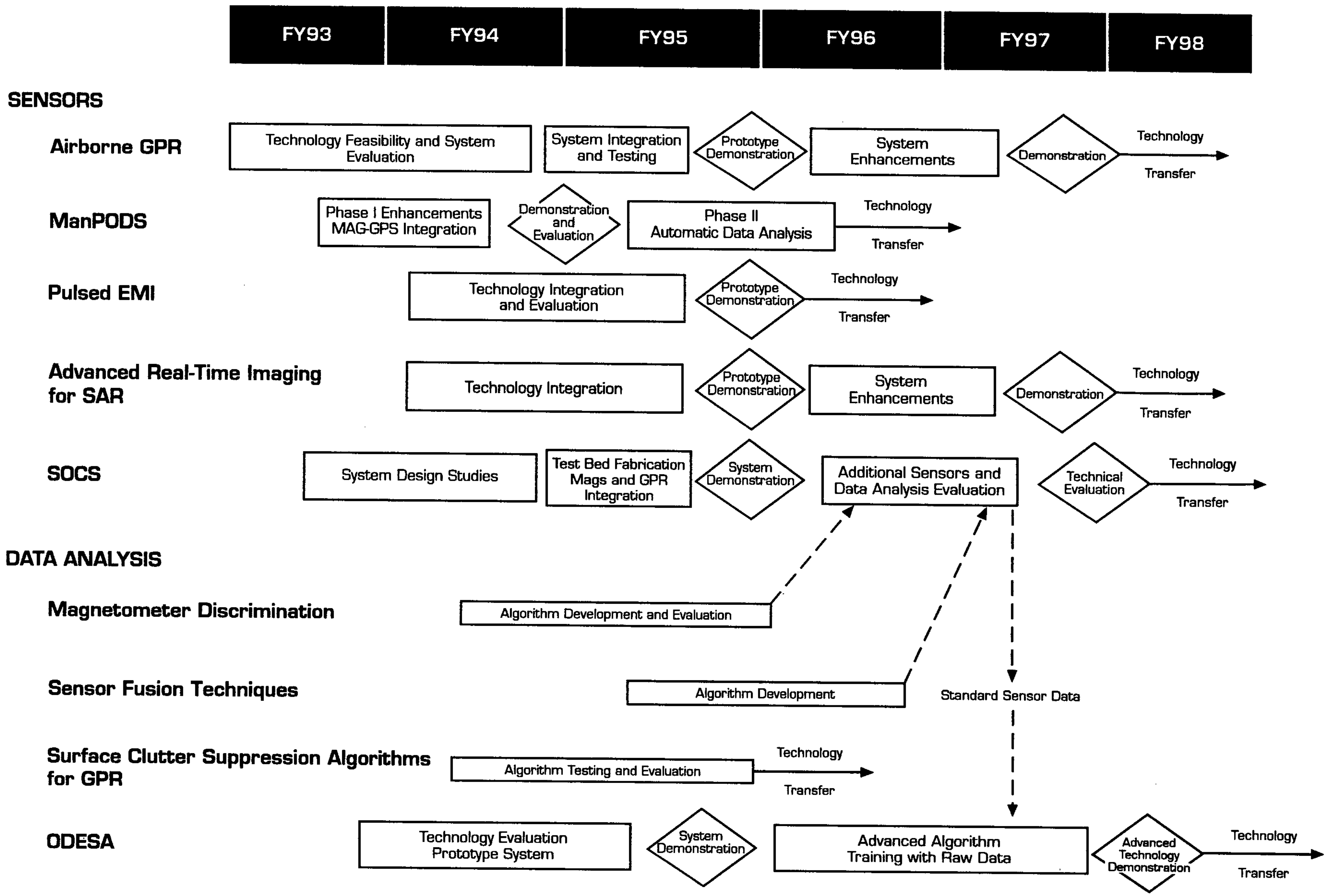
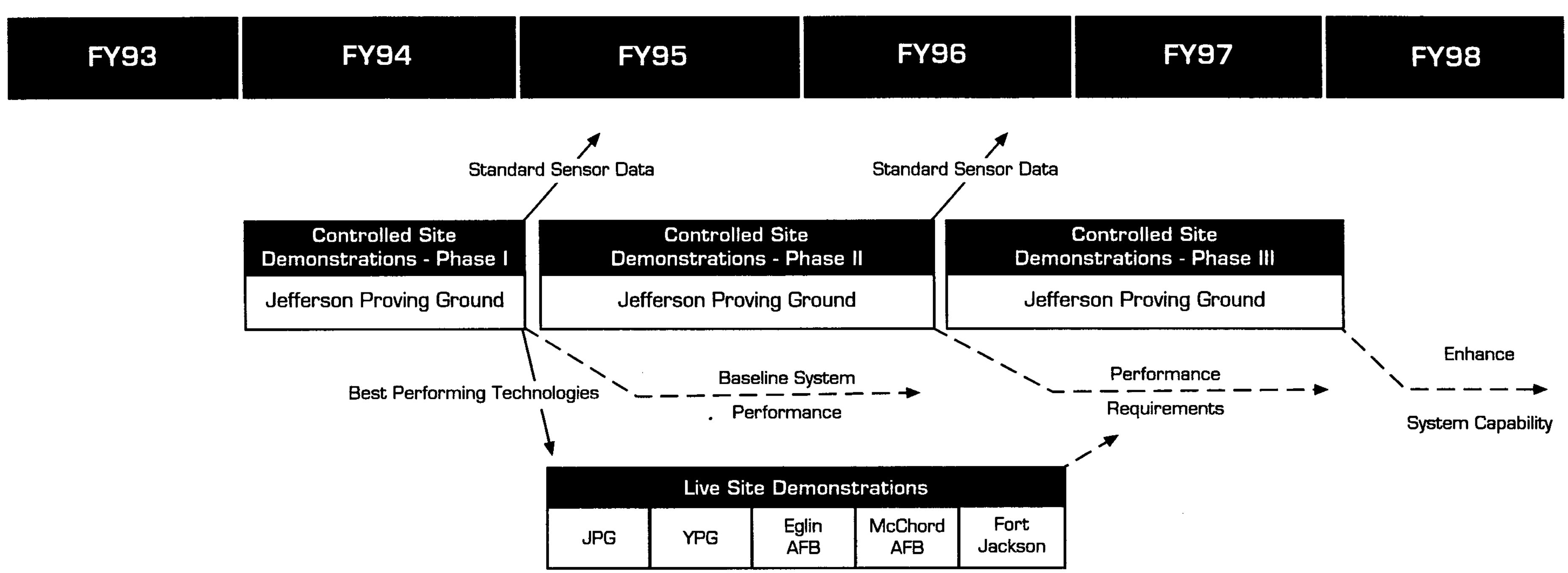


Figure 21

Advanced Technology Demonstrations



Available Documentation

Unexploded Ordnance Advanced Technology Demonstration Program at Jefferson Proving Ground (Phase I), December 1994. USAEC Report No. SFIM-AEC-ET-CR-94120.

Evaluation of Individual Demonstrator Performance at the Unexploded Ordnance Advanced Technology Demonstration Program at Jefferson Proving Ground (Phase I), March 1995. USAEC Report No. SFIM-AEC-ET-CR-95033.

Surface Towed Ordnance Locator System, Scientific and Technical Report, February 1995. USAEC Report No. SFIM-AEC-ET-CR-95042.

System/Design Trade Study Report for the Navigation of the Airbome, Ground Vehicular and Man-Portable Platforms in Support of the Buried Ordnance Detection, Identification, and Remediation Technology, March 1995. USAEC Report No. SFIM-AEC-ET-CR-95043.

Ground Penetrating Radar for Ordnance Contaminated Site Restoration, 14 March 1995. USAEC Report No. SFIM-AEC-ET-CR-95041.

Program

Performers

4 Program Performers

Performers for the U.S. Army Environmental Center Environmental R&D Program

Performers

Argonne National Laboratory	Argonne, IL
Battelle Pacific Northwest Laboratories	Richland, WA
Battelle Pacific Northwest Laboratories	Pasco, WA
Battelle Columbus Laboratories	Columbus, OH
Engineer-Science Inc.	Denver, CO
Cold Regions Research and Engineering Laboratory	Hanover, NH
Concurrent Technologies	Johnstown, PA
Day and Zimmerman/Basil, Inc.	Hawthorne, NV
Department of Energy - Oak Ridge National Laboratory	Oak Ridge, TN
Engineering Science	Denver, CO
Hercules Inc.	Radford, VA
IT Corporation	Cincinnati, OH
National Defense Center for Environmental Excellence	Johnstown, PA
Stone and Webster Environmental Technology and Services	Boston, MA
Naval Surface Warfare Center	Indian Head, MD
Parsons	Pasadena, CA
Roy F. Weston, Incorporated	West Chester, PA
Tennessee Valley Authority	Muscle Shoals, AL
Tobyhanna Army Depot	Tobyhanna, PA
U.S. Army Waterways Experiment Station	Vicksburg, MS
U.S. Army Construction Engineering Research Laboratories	Champaign, IL
Science and Technology Corporation	Hampton, VA
Umatilla Army Depot Activity	Hermiston, OR
University of Delaware	Wilmington, DE